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Black Sea assessments
(STECF 15-16)

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This report was reviewed by the STECF by written procedure during October 2015

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Abstract
The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 15-12 was held from 28 Sep-02 Oct 2015 in Ispra, Italy to assess the status of Black Sea against the proposed F_{MSY} reference points. The meeting was preceded by a two-day data preparatory meeting held at JRC premises during 24-25 Sep 2015. The report was reviewed by written procedure in October 2015.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Black Sea assessments (STECF-15-16)

THIS REPORT WAS REVIEWED BY WRITTEN PROCEDURE DURING OCTOBER 2015

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting 15-12, evaluate the findings and make any appropriate comments and recommendations.

Observations of the STECF

The EWG 15-12 carried out quantitative stock assessments for eight species of commercial fish species in the Black Sea. The assessment of turbot and sprat were considered of enough quality to conduct short term forecast. All other assessments (i.e. whiting, Mediterranean horse mackerel, Black Sea anchovy, piked dogfish, thornback ray and red mullet) were considered only as indicative of trends in terms of SSB and thus short term forecasts were not conducted. However, all assessments were considered of enough quality for defining the status of the stocks in terms of F (or E) compared to F_{MSY} (or E_{MSY}).

STECF does not consider FMSY to be an appropriate target for rapa whelk (Rapana venosa) given that it is an invasive predatory species that the fact that the species has had a negative impact on other native Black Sea species. Thus, the goal for managing rapa whelk should not be to achieve the maximum sustainable yield (MSY) and therefore it is not appropriate to constrain fishing activities to achieve high biomass levels of rapa whelk. Fishing for rapa whelk and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the rapa whelk stock below the level consistent with MSY. Moreover, due to the negative impact of rapa whelk fisheries on the Black sea demersal habitat and in terms of by catch of undersized individuals of other commercial species (e.g. turbot), STECF consider that rapa whelk fisheries should be conducted using only ecologically friendly gears as for example pots.

Conclusions of the STECF

STECF endorses the findings presented in the report of the EWG 15-12 and draws the following conclusions.

Management reference points

STECF concludes that the following limit reference points, which are consistent with high long-term yields are appropriate proxies for F_{MSY}:

- Sprat: $F_{MSY} = F \leq 0.64$, consistent with the exploitation rate $E \leq 0.4$.
- Turbot: $F_{MSY} = F \leq 0.26$, the median F for MSY based on simulations that included model uncertainty in the stock-recruit relationship
- Whiting: $F_{MSY} = F \leq 0.79$, consistent with the exploitation rate $E \leq 0.4$. STECF considers that this value to be at the upper end of the biologically expected value and should be subject to revision in future.
- Mediterranean horse mackerel $E_{MSY} = E \leq 0.40$
- Black Sea anchovy $F_{MSY} = F \leq 0.49$, consistent with the exploitation rate $E \leq 0.4$.
- Piked dogfish: $F_{MSY} = F \leq 0.08$, consistent with $F_{0.1}$.

- Red mullet: F_{MSY} = F ≤ 0.64, consistent with $F_{0.1}$. STECF considers that this value to be at the upper end of the biologically expected value and should be subject to revision in future.
- Thornback ray: F ≤ 0.16, consistent with $F_{0.1}$

Proposed limit and precautionary management biomass reference points proposed are:

- Turbot: B_{lim} = 3,535 t: B_{pa}= 4,949 t.

Stock status

STECF concludes that in relation to the above reference points, the current status of these species in the Black Sea is summarized as follows:

• Sprat: Fishing mortality in 2014 is estimated to be F = 0.45, which is less than F_{MSY} (F = 0.64).
• Turbot: Fishing mortality in 2014 is estimated to be F = 1.40, which is more than five times the F_{MSY} (F = 0.26). The stock has been exploited at rates exceeding F_{MSY} for many years and is severely depleted. SSB in 2014 (1,009 t) is estimated to be less than one third of B_{lim} (3,535 t).
• Whiting: The fishing mortality in 2014 is estimated to be F = 1.08, well above the F_{MSY} (F = 0.79). The stock has been exploited at rates exceeding F_{MSY} for several years.
• Mediterranean horse mackerel: Fishing mortality in 2014 is estimated to be F = 1.5, corresponding to an exploitation rate of E = 0.79, which is almost twice the F_{MSY} exploitation rate of E = 0.4. The stock has been exploited at rates exceeding F_{MSY} for several years.
• Black Sea anchovy: Fishing mortality in 2014 is estimated to be F = 1.01, which is almost twice F_{MSY} (F_{MSY} = 0.49). The stock has been exploited at rates exceeding F_{MSY} for many years even though, fishing mortality has been declining in recent years.
• Dogfish: The fishing mortality rate during 2014 is estimated to be F = 0.24, which is 3 times the F_{MSY} exploitation rate of F = 0.08. Recent catches of this long-lived and relatively unproductive species are very low compared to the past and the stock appears to be severely depleted.
• Red mullet: The fishing mortality rate during 2013 is estimated to be F = 1.07, which is 1.7 times the F_{MSY} exploitation rate of F = 0.64. The stock has been exploited at rates exceeding F_{MSY} for several years.
• Thornback ray: recent exploitation (mean $F_{2008\text{-}2013}$ =0.25) is considered to above the F_{MSY} value (0.16)

Fishing opportunities for 2016

To achieve F_{MSY} in 2016, STECF advises that total international catches from the Black Sea (GSA 29) in 2016 should not exceed the following limits:

• Sprat: 75,960 t.

Because there is no international agreement on the allocation of fishing opportunities for Black Sea stocks, STECF is unable to advise appropriate EU quotas for sprat.

In order to maximise the potential for recovery of the depleted stocks of turbot and piked dogfish in the Black Sea, STECF concludes that fisheries directed to these species should not be permitted in

2016 and that all by-catches mortalities in other fisheries should be minimised. Hence, STECF advises that TACs for turbot and piked dogfish should be set as follows:

- Turbot: 0 t.
- Piked Dogfish: 0 t.

Assessments of whiting, Mediterranean horse mackerel, red mullet, thornback ray and Black Sea anchovy were indicative of trends only and thus of not sufficiently quality to conduct short term forecast to be used as a basis for advice on fishing opportunities for 2016. For these stocks, STECF advises that the relevant fleets' catches and/or effort be reduced until fishing mortality is at or below F_{MSY} or E_{MSY}. STECF notes that catches of these species in 2016 for GSA 29 consistent with F_{MSY} or E_{MSY} cannot be estimated as the assessment is indicative of trends only.

STECF notes that because rapa whelk is an invasive species in the Black Sea and has contributed to the decline of several native stocks of shellfish, STECF considers that it is not appropriate to constrain fishing activities to achieve MSY for rapa whelk. Fishing for rapa whelk and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the stock below the level consistent with MSY. Moreover, due to the negative impact of rapa whelk fisheries on the Black sea demersal habitat and in terms of by catch, STECF consider that rapa whelk fisheries should be conducted using only ecologically friendly gears as for example pots.

Identify areas and periods with high occurrence of juveniles and/or spawners of turbot and piked dogfish

STECF notes that Information of the distribution of juveniles or/and spawners of turbot and spiked dogfish is generally scarce. STECF considers that in order to increase the knowledge on the spatial and temporal distribution of turbot and picked dogfish in the Black Sea there is the need to conducting internationally-coordinated demersal surveys in the Black Sea

Identify and justify other important fisheries and stocks that may be in need of specific management measures

STECF considers that currently no other species in the Black Sea is in need of specific management measure for sustainable exploitation at this present time STECF assessments cover 95% (in terms of landings) of the Black Sea exploited marine resources.

Proposals to enhance knowledge of Black Sea stocks and fisheries

- STECF considers that it is desirable that demersal and hydroacoustic surveys are expanded to cover a greater proportion of the Black Sea, and be conducted annually. Improved coordination of the existing national surveys should also be considered.
- STECF considers that a review of the fishery sampling programs of the Black Sea nations needs to be undertaken. The review should document how the fishery and stock assessment data in the Black Sea are collected and identify the causes of the data gaps that were apparent in the information provided to EWG 15-12.

- STECF considers that mechanisms need to be established for all Black Sea stocks to ensure that age reading specialists in the different national laboratories all use the same agreed protocols for age-determination. Procedures should also be developed to ensure that the age-readings are maintained to an acceptable quality standard.
- STECF considers that increased at-sea sampling to collect discards data for the different Black Sea fisheries is required.
- STECF considers that as was the case in 2015, prior to the 2016 EWG on the assessment of Black Sea stocks, a data workshop to agree and documented procedures for compiling a time-series of stock assessment input data is highly desirable.

Expert Working Group EWG-15-12 report

Report to the STECF

EXPERT WORKING GROUP ON
Black Sea assessments
(EWG-15-12)

Ispra, Italy, 28 Sep - 2 Oct 2015

(including a data preparatory meeting: 24-25 Sep 2015)

1. Executive summary

In response to the ToR the STECF EWG 15-12 on Black Sea Sea stock assessments has endeavoured to develop stock assessments for eight stocks (Table 1). Relevant data were compiled and reviewed, including those called officially by DG Mare through the 2015 DCF data call for the Mediterranean and Black Sea. A two-day data preparatory meeting preceeded the main meeting and selected experts coordinated the compilation of the necessary data, which were later analyzed using a variety of stock assessment approaches. The data and methods applied to the eight stocks are documented in section 5 of the present report.

Among the eight stocks assessed (ToRs 1-8; Table 1), two (i.e. turbot and sprat) were of enough quality to conduct a short term forecast. For the remaining six stocks, the assessment was considered as indicative of trends only in terms of SSB and thus short term forectas were not conducted. However, all assessments were considered of enough quality for defining the status of the stocks in terms of F (or E) compared to F_{MSY} (or E_{MSY}). A summary of the status of the stocks assessed during EWG 15-12 is presented in Table 1. With the exception of sprat, all stocks are fished above F_{MSY} or above E_{MSY} in 2014.

Turbot spawning biomass is estimated to be less than 30% of the estimated B_{lim} and F is about five times the F_{MSY} value in 2014. Thus, on the basis of precautionary considerations, there should be no directed fisheries for turbot in GSA 29 and all bycatches mortality should be minimized in 2016.

Piked dogfish spawning biomass is estimated to be at the lowest level since 1988 and F is more than three times F_{MSY} in 2014. Thus, on the basis of precautionary considerations, there should be no directed fisheries for Piked dogfish in GSA 29 and all bycatches mortality should be minimized in 2016.

For the other stocks (red mullet, anchovy, horse mackerel, whiting and thornback ray) STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed F_{MSY} (or E_{MSY}) level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of multi-annual management plan taking into account mixed-fisheries considerations. Catches of red mullet, anchovy, horse mackerel, whiting and thornback ray in GSA 29 in 2016 consistent with F_{MSY} (or E_{MSY}) cannot be estimated as the assessments are only indicative of trends.

Concerning Rapa whelk EWG 15-12 (ToR 8), reiterates previous STECF conclusions made in 2013. EWG 15-12 does not consider F_{MSY} to be an appropriate target for rapana given that it is an invasive predatory species that the fact that the species has had a negative impact on other native Black Sea species. Thus, the goal for managing rapana should not be to achieve the maximum sustainable yield (MSY) and therefore it is not appropriate to constrain fishing activities to achieve high biomass levels of rapana. Fishing for rapana and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the rapana stock below the level consistent with MSY. The impact of rapana on its prey is very important to document and monitor. Black Sea nations need to create common indices to monitor the distribution trend and pattern of Rapa whelk in the region. The negative impacts of trawls and dredges fishing for rapana on other important commercial species (e.g. turbot) and on the Black Sea habitat and biodiversity are widely known. EWG 15-12 consider that more ecological friendly methods and gears should be encouraged (i.e. traps), although it is considered that commercial fisheries is the unique way to eradicate or at least control this species in the Black Sea. The recently introduced EU Regulation 1143/2014 on invasive alien species (IAS) seeks to address the problem in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. Among others, it also deals with the issue of "Management of already established IAS in the EU". Therein it is quite clear that there is only the option of minimizing or even erradicating them, and this is promoted through a series of succesful efforts on various species (terrestial, marine) accompanied by the optimal methodology for doing so. However the Committee on IAS will have to draft by the end of 2015 a 'black list' of species; following that, all members states facing the problem will have to come up with a series of measures by the end of 2016. It is unclear how will the Rapa whelk be dealt within this Committee on IAS taking into account the significant socio-economical aspect of its fishery.

Concerning ToR 9 (turbot IUU catches), EWG 15-12 considers that currently existing and accessible literature sources do not enable the formulation of new scientific based approach for the calculating of the IUU rates by countries and therefore the same approach for estimating IUU catches of turbot in the Black Sea used in 2014 by EWG 14-14 was used also in 2015 by EWG 15-12, which estimates the IUU to be 4.7 times the official catches of Ukrainian, Romanian and Bulgarian.

Concerning ToR 10 (data quality), EWG 15-12 considers that current assessments are hindered by the lack of internationally coordinated hydro-acoustic surveys for sprat, whiting, horse mackerel and anchovy and demersal internationally coordinated trawl survey for turbot, red mullet, piked dogfish and thornback ray. Mreover, there is a general lack of landings data, catch at length and catch at age data and CPUE from surveys and commercial fleets from Georgia and Russia. The current assessments will benefit from a internationally coordinated data collection program for catch data covering the entire Black Sea.

Concerning ToR 11, EWG 15-12 considers that currently no other species in the Black Sea is in need of specific management measure for sustainable exploitation.

Table 1. Synoptic table of the stock assessed during EWG 15-12. In red are stocks for which current F (2014) or E (2014) is larger than F_{MSY} or E_{MSY} and current SSB (2014) is smaller than B_{lim}.

Stock area	Common name	Assessment	Comment	F*	F_{MSY}	F/F_{MSY}	B_{lim}	B_{curr}	B/B_{lim}	Short term	Advice***
GSA 29	Turbot	SAM		1.40	0.26	5.38	3535	1009	0.29	Yes	0 t
GSA 29	Red mullet	XSA	Only indicative of trends	1.07	0.64	1.67				No	
GSA 29	Anchovy	XSA	Only indicative of trends	0.53**	0.40**	1.32				No	
GSA 29	Horse mackerel	XSA	Only indicative of trends	0.79**	0.40**	1.97				No	
GSA 29	Dogfish	XSA	Only indicative of trends	0.24	0.08	3.00				No	0 t
GSA 29	Whiting	XSA	Only indicative of trends	0.73**	0.40**	1.83				No	
GSA 29	Sprat	ICA		0.32**	0.40**	0.80				Yes	75960 t
GSA 29	Thornback ray	VIT	Only indicative of trends	0.25	0.16	1.56				No	

* F of the last year (2014)
** Exploitation rate
***2016

2. Findings And Conclusions Of The Working Group

See stock specific summary sheets.

3. Follow Up Items

The text below highlights some issues that arose during the EWG 15-12 meeting that were created difficulties for the meeting or the process of completing the report. The EWG offers the following suggestions for next year to improve the process for preparing assessments of the Black Sea stocks:

(1) Bulgaria will need to initiate a sampling scheme for discards as expected under the European data collection program.

(2) Turbot IUU catches can be more realistically estimated through the official records of inspections conducted on board commercial vessels targeting turbot. A relevant campaign is running since 2011 and is to be continued till 2018. A collaboration with EFCA (Vigo) and GFCM is essential to this end.

(3) The data preparatory meeting can be considered a success and should be established in the years to come as a good practice.

(4) There is a general lack of landings data, catch at length and catch at age data and CPUE from surveys and commercial fleets from Georgia and Russia. The current assessments will benefit from a internationally coordinated data collection program for catch data covering the entire Black Sea.

(5) Current assessments are hindered by the lack of internationally coordinated hydro-acoustic surveys for sprat, whiting, horse mackerel and anchovy and demersal internationally coordinated trawl survey for turbot, red mullet, piked dogfish and thornback ray.

4. Introduction

The expert working group on Black Sea stock and fisheries assessment STECF EWG 15-12 was held in Ispra, (Italy) betwen 28th September and 2nd Octber 2015. It was preceeded by a two-day data preparatory meeting betwen September 24th and 25th 2015.

The chairman opened the meeting at 09:00 on Monday, 28th September 2015, and adjourned the meeting by 16:00 on Friday, 2nd Octber 2015. The meeting was attended by 17 experts in total, including 2 STECF members and an additional 1 JRC expert.

The data preparatory meeting was held between 09:30 on Thursday 24th September 2015 and 17:00 on Friday 25th September 2015.

The structure of the present report is in accordance with the terms of reference to STECF, as defined in the following chapter.

4.1 Terms Of Reference For Ewg-15-12

Table 4.1.1. List of proposed stocks.

Nb	Common name	Scientific name	Priority
1	Sprat	*Sprattus sprattus*	High
2	Turbot	*Psetta maxima*	High
3	Red mullet	*Mullus barbatus*	High
4	Anchovy	*Engraulis encrasicolus*	Medium
5	Mediterranean horse mackerel	*Trachurus mediterraneus*	High
6	Piked dogfish	*Squalus acanthias*	High
7	Whiting	*Merlangus merlangus*	Medium
8	Thornback ray	*Raja clavata*	

For the eight stocks given in Table 4.1.1, the STECF-EWG 15-12 is requested to:

ToR 1 – **Compile and provide complete sets** of national annual data on landings, discards, landings at age, discards at age, mean weight at age in the landings, mean weight at age in the discards, maturity ogives at age and natural mortality at age by area for the longest time series available up to and including 2014. Special focus shall be given to bycatch of elasmobranch. The data should be compiled based on official data bases, best expert knowledge and by using the results of scientific surveys.

ToR 2 - Compile and provide all fishery independent data (pelagic, demersal, hydro-acoustic surveys) for the stocks as available, their juveniles. In order to allow the use of such data to potentially calibrate virtual population analyses, the indices of abundance at age should be compiled for the longest time series available up to and including 2014.

ToR 3. - **Compile and provide complete sets of annual fishing effort data** (number of vessels, kW*days, GT*days, fished hours) by nation, for fleets and gears (by mesh size where applicable), and area for the longest time series available up to and including 2014. Data on fishing effort shall be provided by fleet segments and shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline.

ToR 4 – **Assess trends in historic stock parameters** for the longest time series available up to and including 2014 (fishing mortality at age, spawning stock biomass, stock biomass, recruits). Different assessment models should be applied as appropriate, including retrospective analyses.

ToR 5 – **Propose and evaluate candidate limit and target reference points** consistent with precautionary approach and MSY framework

ToR 6 - Predict spawning stock biomass, stock biomass, recruits and catches at age and in weight in, 2015, 2016 and the beginning of 2017 under different management scenarios including: (a) status quo fishing mortality and; (b) fishing mortality that will allow achieving MSY levels at the shortest possible timeframe. Only for turbot and sprat, evaluate the implications of these scenarios on defining autonomous TAC for 2016

ToR 7 - Up-date the description of fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort by fleet segment (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality.

ToR 8 - STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based on the data format of the official DCF data calls for the Black Sea issued on April 2015. In particular, STECF is requested to identify data gaps and ways to overcome them with a view to obtain scientifically acceptable stock assessments for the species in Table I. In case, the proposed data poor stocks (Table II) cannot be finally assessed, STECF is requested to include those species in the evaluation. Regarding Rapa whelk the identification of specific data needs to perform a stock assessment should be part of the preparatory meeting and the results included in the final report of the EWG 15-12

ToR 9 - Review the methodology used during previous EWG for estimating the level of IUU catches of turbot and make any appropriate comments and recommendations to improve the current method. The EWG shall deal with this ToR as part of the preparatory meeting, and the results included in the final report of EWG 15-12.

ToR 10 - On the basis of the existing information, **identify areas and periods with high occurrence of juveniles and/or spawners of turbot and piked dogfish**.

ToR 11 - Identify and justify other important fisheries and stocks that may be in need of specific management measures to ensure sustainable exploitation and analyse whether the scientific basis is adequate or needs to be further developed.

In support of its advice, STECF shall provide for each stock, to the extent possible:

a) a full methodological description of the assessment and advisory procedure updated whenever a significant change is made;

b) estimates of landings, fishing mortality, recruitment and spawning stock together with information or estimates of the uncertainty with which these parameters are estimated;

5 ASSESS TRENDS IN HISTORIC AND RECENT STOCK PARAMETERS

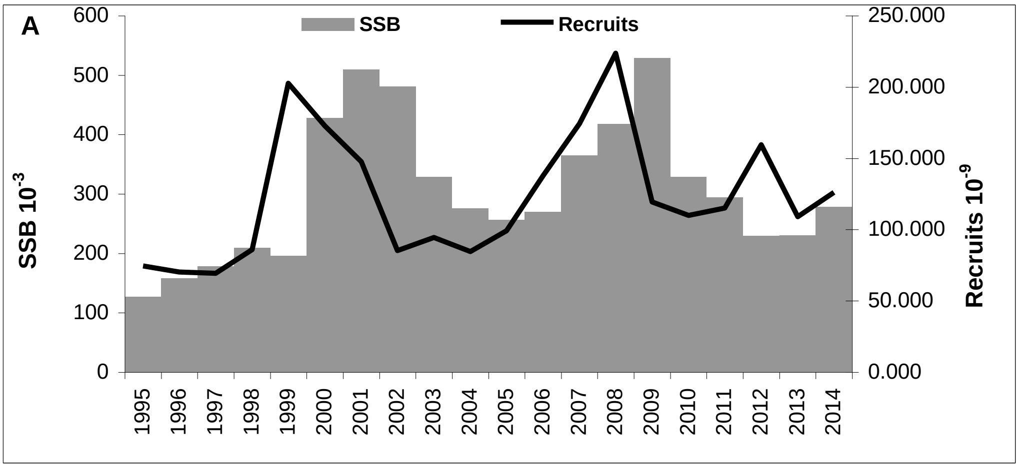
5.1 SUMMARY SHEETS

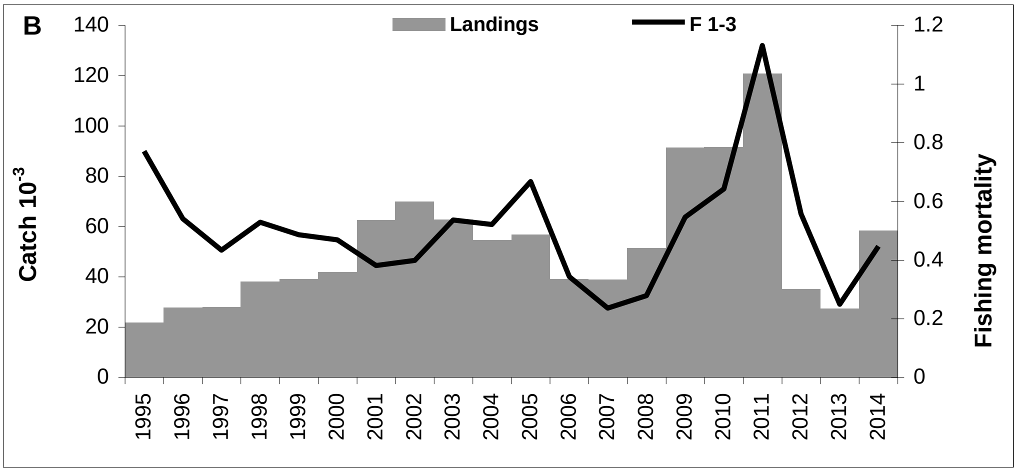
5.1.1 SPRAT

Species common name: Sprat
Species scientific name: *Sprattus sprattus*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.1.1 Stock development over time

In 2014, SSB is estimated at 277 720 t, which is around the average of the time series (200 000-300 000 t). Recruitment has been relatively low in 2010-2011 but has increased in 2012. The current explotation rate (E = 0.32, which corresponds to an F = 0.45) is smaller than E_{MSY} (0.40, which corresponds to an F = 0.64), indicatings that sprat in GSA 29 is being fished below E_{MSY}.





Sprat in GSA 29. ICA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.1.2 Stock advice

STECF EWG 15-12 advises that catches in 2016 shoud be no more than 75,960 tonnes, which corresponds to E_{MSY} (0.40).

5.1.1.3 Basis of the assessment

The stock was assessed using an Integrated Catch-at-age Analysis (ICA; Patterson and Melvin. 1996). Catch and weight at age, natural mortality, and 5 age structured fish abundance indices were used to run ICA. Total catch at age data were compiled by summing catch at age matrices from Bulgaria, Romania, Russia, Turkey and Ukraine. Five age structured indices were used: CPUE from Bulgarian, Ukrainian and Turkish commercial sprat fleets and relative fish abundance indices from the Romanian Pelagic Trawl Survey, and Bulgarian Acoustic survey.

5.1.1.4 Catch options

Catch options are summarized in the following table 5.1.1.4.1.

Table 5.1.1.4.1. Sprat in the Black Sea. Short term forecast in different F scenarios computed for sprat in GSA 29. Basis: F(2015) = mean(F_{bar} 1-3 2012-2014)= 0.45; R(2015) = geometric mean of the recruitment of the last 3 years; R = 126 016 211 thousands; SSB(2014) = 277720 t, Catch (2014)= 58380 t.

		2015				2016					2017	
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock bioma	catch in weight	stock biomass	sp. stock bioma	catch
1.0000	0.4461	399130	273114	58342	0.0000	0.0000	398346	272330	0	436970	310954	0
					0.1000	0.0446	398346	272330	6504	432575	306559	7970
					0.2000	0.0892	398346	272330	12790	428349	302333	15313
					0.3000	0.1338	398945	272929	18865	425404	299388	22088
					0.4000	0.1749	398945	272929	24744	421450	295434	28349
					0.5500	0.2404	398945	272929	33209	415788	289772	36879
					0.6000	0.2623	398945	272929	35943	413969	287953	39515
					0.7000	0.3123	398945	272929	41282	410427	284411	44498
					0.8000	0.3569	398945	272929	46456	407008	280992	49128
					0.9000	0.4015	398945	272929	51476	403704	277688	53441
				Fsq	**1.0000**	**0.4461**	**398346**	**272330**	**56346**	**399612**	**273596**	**57459**
					1.1000	0.4907	398945	272929	61074	397424	271408	61209
					1.2000	0.5354	398945	272929	65667	394435	268419	64715
					1.3000	0.5800	398945	272929	70130	391542	265526	67998
					1.4000	0.6246	398945	272929	74470	388741	262725	71075
					1.5000	0.6692	398945	272929	78690	386025	260009	73962
				Fmsy	**1.435**	**0.640**	**398945**	**272929**	**75960**	**387781**	**261765**	**72106**

5.1.1.5 Reference points

Table 5.1.1.5.1. Sprat in GSA 29 Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	E_{MSY}	0.40	Patterson exploitation rate for small pelagics	
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.1.6 Quality of the assessment

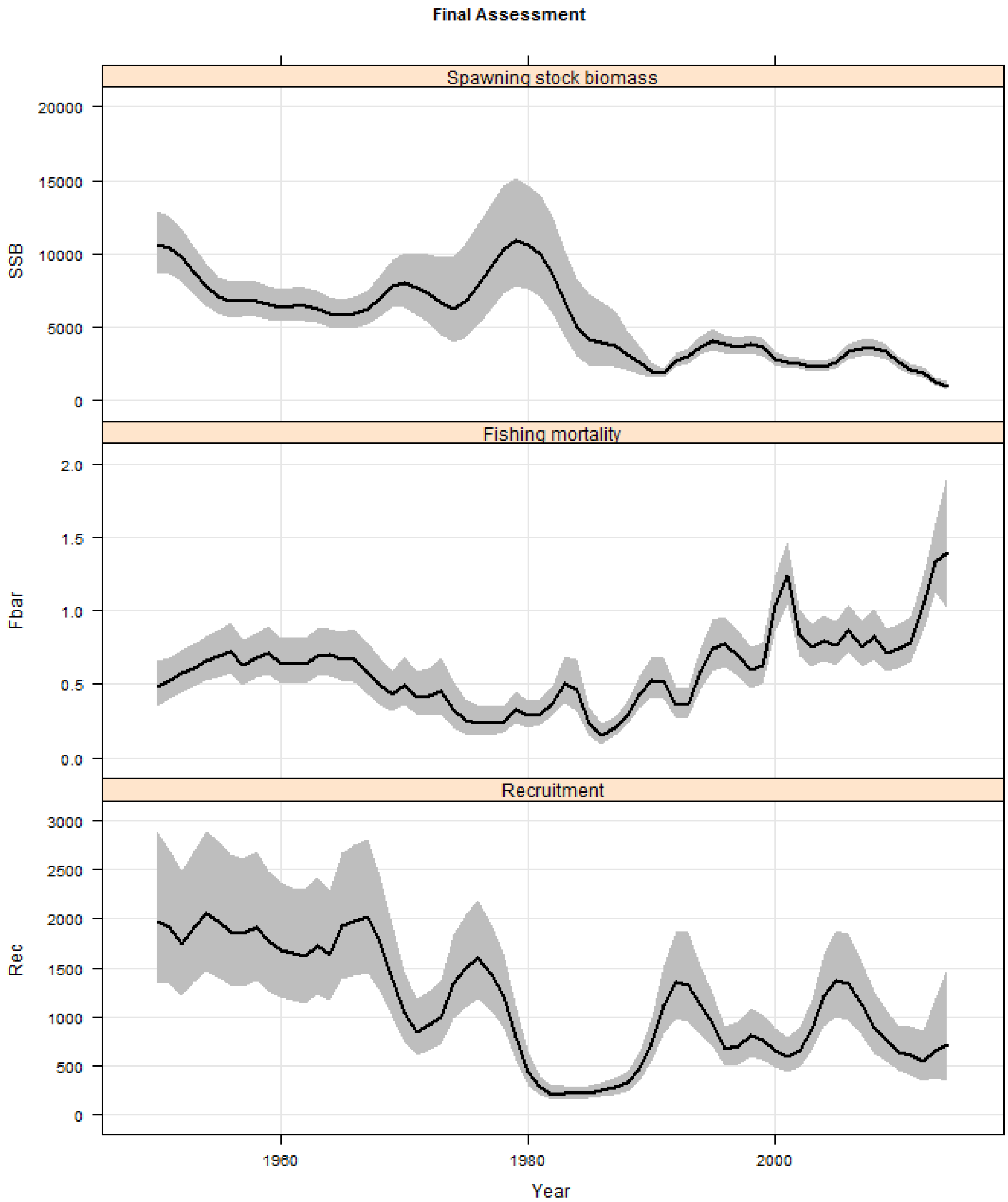
The detailed assessment can be found in section 5.2.1.

5.1.2 TURBOT

Species common name: Black sea turbot
Species scientific name *Psetta maxima / Scophthalmus maximus*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.2.1 Stock development over time

SSB declined from a peak in 1977 – 1982 to the minimum value observed in the times series in 2014 (1009 t), which is less than 30% of the estimated B_{lim} (3535 t). Recruitment showed has four peaks, in 1965 – 1968, 1974 – 1978, 1991 – 1994 and 2004 – 2007 and three lows in 1982-84, 1996 – 1997. After 2009, recruitment has been low. Fishing mortality has increased continuosly since the beginning of the 1990s reaching a peak in 2014 around 1.4. The current F (1.40) is larger than F_{MSY} (0.26), which indicates that turbot in GSA 29 is being fished above F_{MSY}.



Turbot in GSA 29. SAM summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.2.2 Stock advice

STECF EWG 15-12 advises that on the basis of precautionary considerations, there should be no directed fisheries for turbot in GSA 29 and all bycatches mortality should be minimized in 2016. This corresponds to a 0 TAC in 2016 for this species.

5.1.2.3 Basis of the assessment

Turbot stock in the Black Sea was assessed by state-space assessment model (SAM) in FLR environment. The data set for the period 1950-2014 was compiled using the historical data sources and new data for 2014. Five tuning series (4 surveys and 1 commercial CPUE series were compiled from the previous assessments and recent data. In 2014, 3 surveys were updated – Romanian and Bulgarian research surveys and the Turkish CPUE survey.

5.1.2.4 Catch options

Catch options are summarized in the following table 5.1.2.4.1.

Table 5.1.2.4.1. Short term forecast in different F scenarios computed for turbot in GSA 29. Basis: F(2015) = mean(F_{bar} 4-8 2012-2014)= 1.26; R(2015) = geometric mean of the recruitment of the last 3 years; R = 640 thousands; SSB(2014) = 1009 t, Catch (2014)= 1159 t.

F scenario	Fmult	Catch 2015	Catch 2016	Catch 2017	Lan-dings 2015	Lan-dings 2016	Lan-dings 2017	SSB 2015	SSB 2016	SSB 2017	Change SSB 2015-2017	Change Catch 2016-2014
0.26	0.21	775.46	202.7	308.88	775.46	202.7	308.88	994.83	1195.68	1772.21	78.14	-81.68
0	0	775.46	0	0	775.46	0	0	994.83	1253.98	2098.1	110.9	-100
0.13	0.1	775.46	102.62	170.23	775.46	102.62	170.23	994.83	1225.25	1929.67	93.97	-90.73
0.25	0.2	775.46	196.49	300.97	775.46	196.49	300.97	994.83	1197.56	1781.79	79.11	-82.24
0.38	0.3	775.46	282.9	403.76	775.46	282.9	403.76	994.83	1170.85	1650.54	65.91	-74.43
0.5	0.4	775.46	362.89	485.96	775.46	362.89	485.96	994.83	1145.06	1533.01	54.1	-67.2
0.63	0.5	775.46	437.26	552.4	775.46	437.26	552.4	994.83	1120.13	1427.01	43.44	-60.48
0.75	0.6	775.46	506.68	606.43	775.46	506.68	606.43	994.83	1096.03	1330.83	33.77	-54.21
0.88	0.7	775.46	571.69	650.41	775.46	571.69	650.41	994.83	1072.69	1243.16	24.96	-48.33
1.01	0.8	775.46	632.72	686.13	775.46	632.72	686.13	994.83	1050.1	1162.92	16.9	-42.82
1.13	0.9	775.46	690.16	714.97	775.46	690.16	714.97	994.83	1028.19	1089.26	9.49	-37.63
1.26	1	775.46	744.31	738	775.46	744.31	738	994.83	1006.95	1021.43	2.67	-32.73
1.38	1.1	775.46	795.45	756.13	775.46	795.45	756.13	994.83	986.34	958.85	-3.62	-28.11
1.51	1.2	775.46	843.83	770.07	775.46	843.83	770.07	994.83	966.32	900.98	-9.43	-23.74
1.63	1.3	775.46	889.63	780.45	775.46	889.63	780.45	994.83	946.87	847.38	-14.82	-19.6
1.76	1.4	775.46	933.06	787.79	775.46	933.06	787.79	994.83	927.97	797.65	-19.82	-15.68
1.88	1.5	775.46	974.27	792.54	775.46	974.27	792.54	994.83	909.59	751.46	-24.46	-11.95
2.01	1.6	775.46	1013.42	795.06	775.46	1013.42	795.06	994.83	891.71	708.49	-28.78	-8.41
2.14	1.7	775.46	1050.63	795.7	775.46	1050.63	795.7	994.83	874.3	668.48	-32.8	-5.05
2.26	1.8	775.46	1086.04	794.73	775.46	1086.04	794.73	994.83	857.35	631.18	-36.55	-1.85
2.39	1.9	775.46	1119.76	792.39	775.46	1119.76	792.39	994.83	840.84	596.37	-40.05	1.2
2.51	2	775.46	1151.88	788.9	775.46	1151.88	788.9	994.83	824.75	563.86	-43.32	4.1

5.1.2.5 Reference points

Table 5.1.2.5.1 Turbot in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.26	EQSim analysis	STECF (2014)
Precautionary approach	B_{lim}	3535	$B_{lim} = B_{pa}/1.4$	STECF (2014)
	B_{pa}	4949	$0.39*B_{max}$ (12689 t)	STECF (2014)
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.2.6 Quality of the assessment

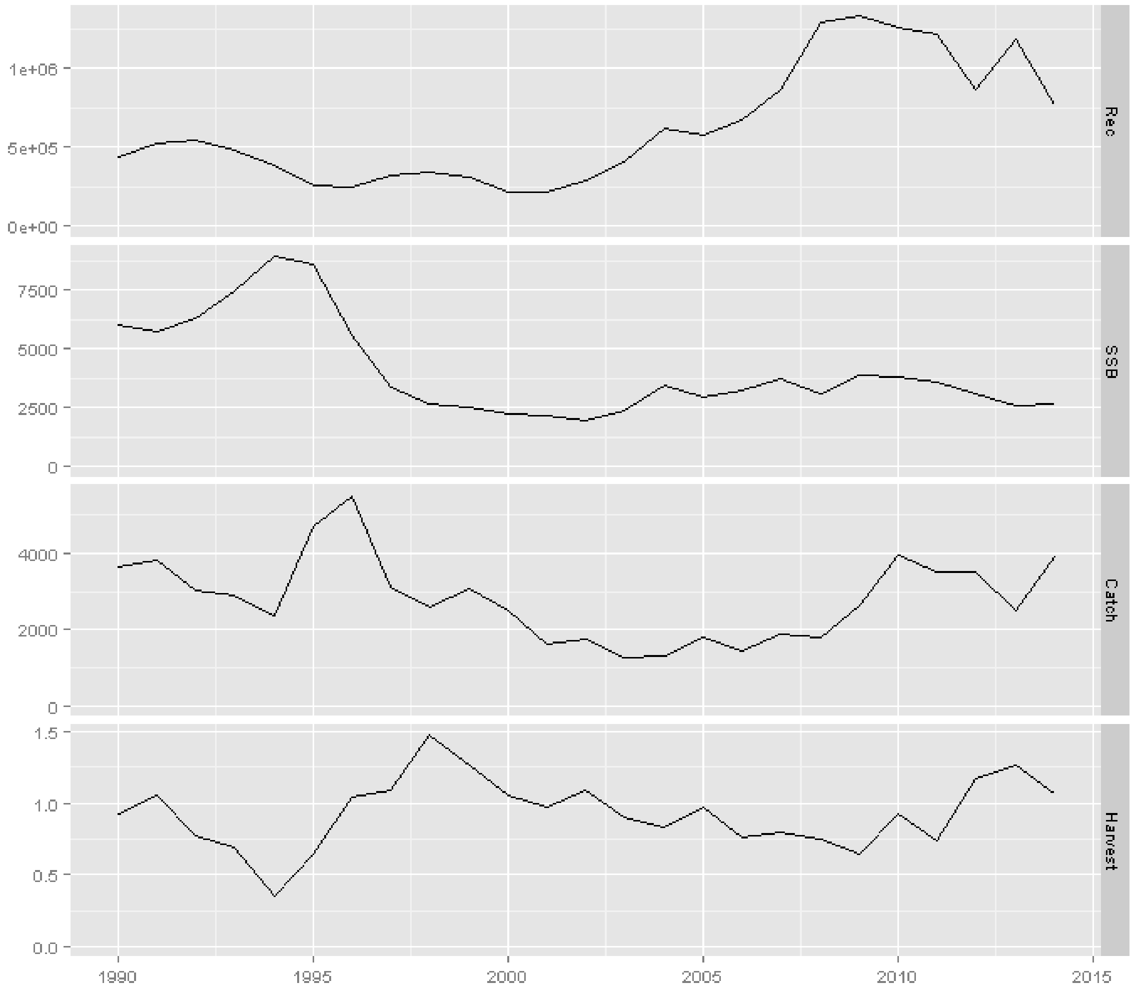
The detailed assessment can be found in section 5.2.2.

5.1.3 RED MULLET

Species common name: Red mullet
Species scientific name: *Mullus barbatus*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.3.1 Stock development over time

The SSB declined in the late 1990s and has oscillated around 2500-3000 t thereafter. Recruitment increased since 2000 with several large year classes observed in recent years. Fishing mortality has oscillated between 0.80 - 1.40 over the time series, except in 1993. The current F (1.07) is larger than F_{MSY} (0.64), which indicates that red mullet in GSA 29 is being fished above F_{MSY}.



Red mullet in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.3.2 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level (0.64), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of red mullet in GSA 29 in 2016 consistent with F_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.1.3.3 Basis of the assessment

The state of exploitation was assessed applying the Extended Survivor Analysis (XSA) method calibrated with Turkish bottom-trawl survey data. In addition, a yield-per-recruit (Y/R) analysis was carried out. Data for the period 1990 to 2014 in terms of catch at ages (0 - 6+), weights at age, maturity and natural mortality were used.

5.1.3.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.3.5 Reference points

Table 5.1.3.5.1 Red mullet in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.64	$F_{0.1}$	STECF 2014
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.3.6 Quality of the assessment

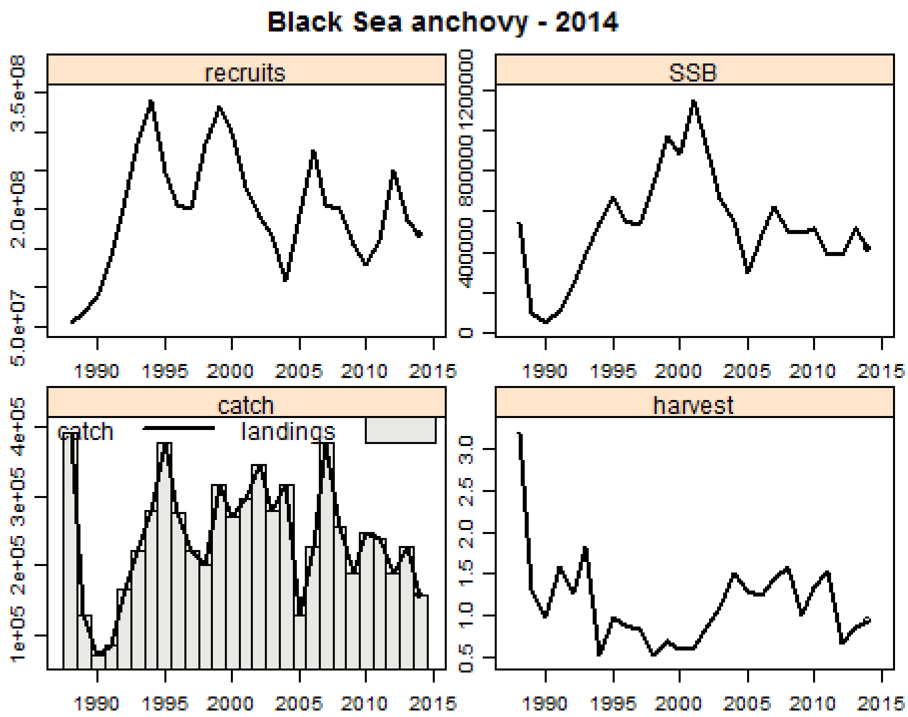
The detailed assessment can be found in section 5.2.3.

5.1.4 ANCHOVY

Species common name: Black Sea Anchovy
Species scientific name *Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.4.1 Stock development over time

The spawning stock biomass showed a peak in 2011 and declined thereafter to values around 400,000 t. In all model runs recruitment displayed a cyclic pattern with peaking values observed in 1994, 1999, 2006, 2012. F has largely declined from the high values observed in the 1990s, and it is estimated around 0.90 in recent years (1.01 in 2014). The current explotation rate (E = 0.53, which corresponds to an F = 1.01) is smaller than E_{MSY} (0.40, which corresponds to an F = 0.49), which indicates that anchovy in GSA 29 is being fished above E_{MSY}.



Anchovy in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.4.2 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of anchovy in GSA 29 in 2016 consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.1.4.3 Basis of the assessment

The state of exploitation was assessed for the period 1988-2014 applying the Extended Survivor Analysis (XSA) method calibrated with Turkish commercial CPUE.

5.1.4.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.4.5 Reference points

Table 5.1.4.5.1. Anchovy in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}			
Exploitation rate	E_{MSY}	0.40	Patterson exploitation rate for small pelagics	STECF 2014
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.4.6 Quality of the assessment

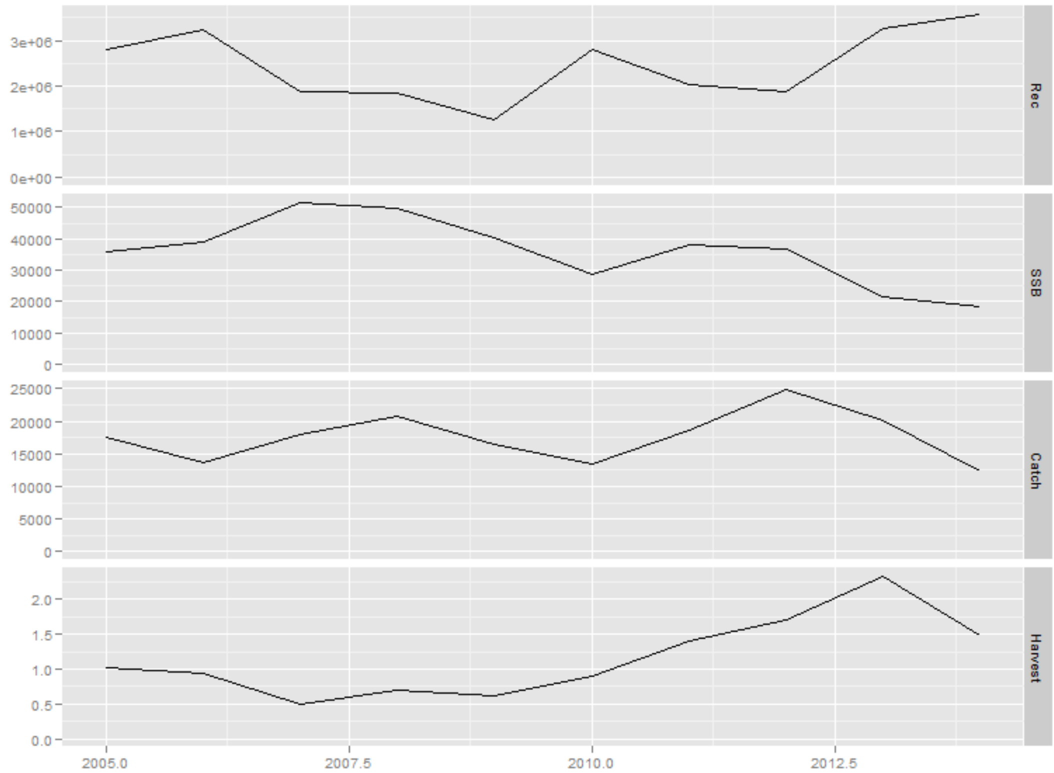
The detailed assessment can be found in section 5.2.4.

5.1.5 MEDITERRANEAN HORSE MACKEREL

Species common name: Mediterranean Horse Mackerel
Species scientific name: *Trachurus mediterraneus ponticus*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.5.1 Stock development over time

SSB has declined from a peak in the middle of the 2000s (50000 t) to a minimum in 2014 at around 20000 t. Recruitment has increased in the recent years with two relative large year classes in 2013 and 2014. F has increased along the time series reaching a peak in 2013 around 2. The current explotation rate (E = 0.79, which corresponds to an F = 1.50) is larger than E_{MSY} (0.40, which corresponds to an F = 0.27), which indicates that Mediterranean Horse Mackerel in GSA 29 is being fished above E_{MSY}.



Mediterranean Horse Mackerel GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.5.2 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of Mediterranean Horse Mackerel in GSA 29 in 2016 consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.1.5.3 Basis of the assessment

An XSA analysis was performed using 2005-2014 data using catch at age data and a tuning index based on commercial CPUE data from the Turkish fleet.

5.1.5.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.5.5 Reference points

Table 5.1.5.5.1. Mediterranean Horse Mackerel in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	E_{MSY}	0.4	Patterson exploitation rate for small pelagics	STECF 2014
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.5.6 Quality of the assessment

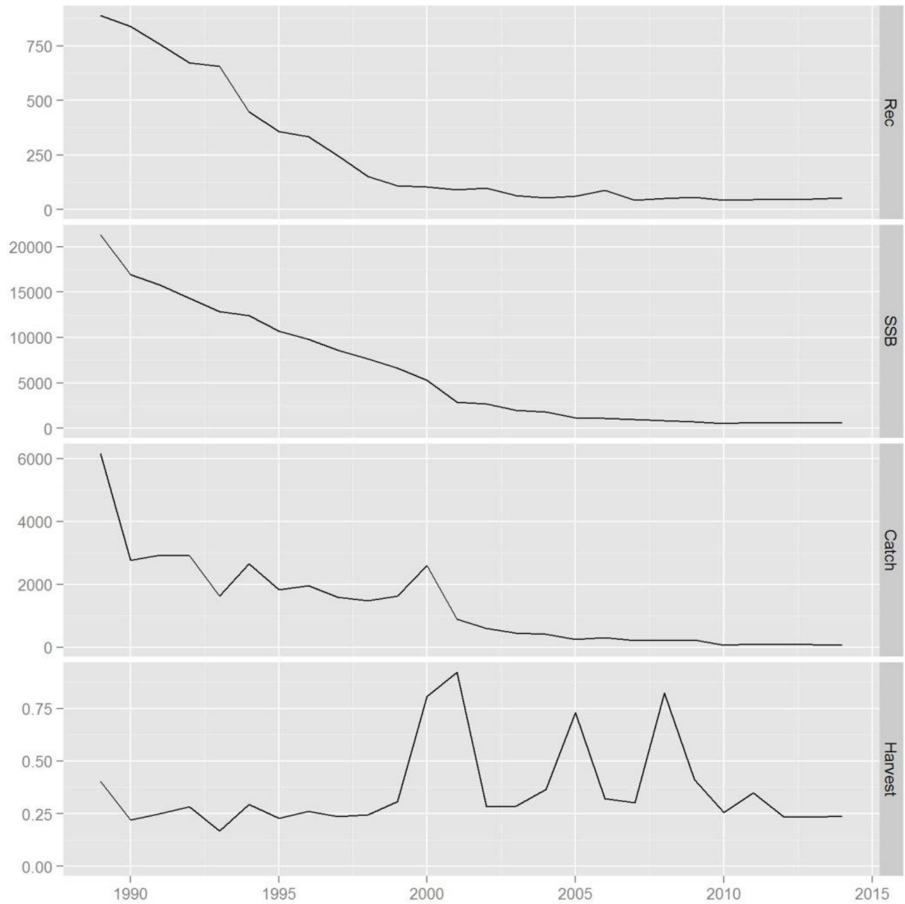
The detailed assessment can be found in section 5.2.5.

5.1.6 PIKED DOGFISH

Species common name: Piked dogfish
Species scientific name *Squalus acanthias*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.6.1 Stock development over time

SSB and recruitment are estimated to be at the lowest observed value over the entire time series. F has shown large historical oscillation and it is estimated to be around 0.25 in recent years. The current F (0.24) is larger than F_{MSY} (0.08), which indicates that Piked dogfish in GSA 29 is being fished above F_{MSY}.



Piked dogfish in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.6.2 Stock advice

STECF EWG 15-12 advises that on the basis of precautionary considerations, there should be no directed fisheries for piked dogfish in GSA 29 and all bycatches mortality should be minimized in 2016. This corresponds to a 0 TAC in 2016 for this species.

5.1.6.3 Basis of the assessment

Extended Survivor Analysis (XSA) was applied to assess the stock status from 1989 to 2014. The catch-at-age matrices were based on length compositions and age/length keys from Ukrainian and

Romanian samples. Natural mortality (M) was assumed constant at 0.15. CPUE at age derived from the Romanian scientific demersal surveys (2009-2014) was used as tuning fleet.

5.1.6.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.6.5 Reference points

Table 5.1.6.5.1 Piked dogfish in Black Sea. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.08	$F_{0.1}$	Present assessment
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.6.6 Quality of the assessment

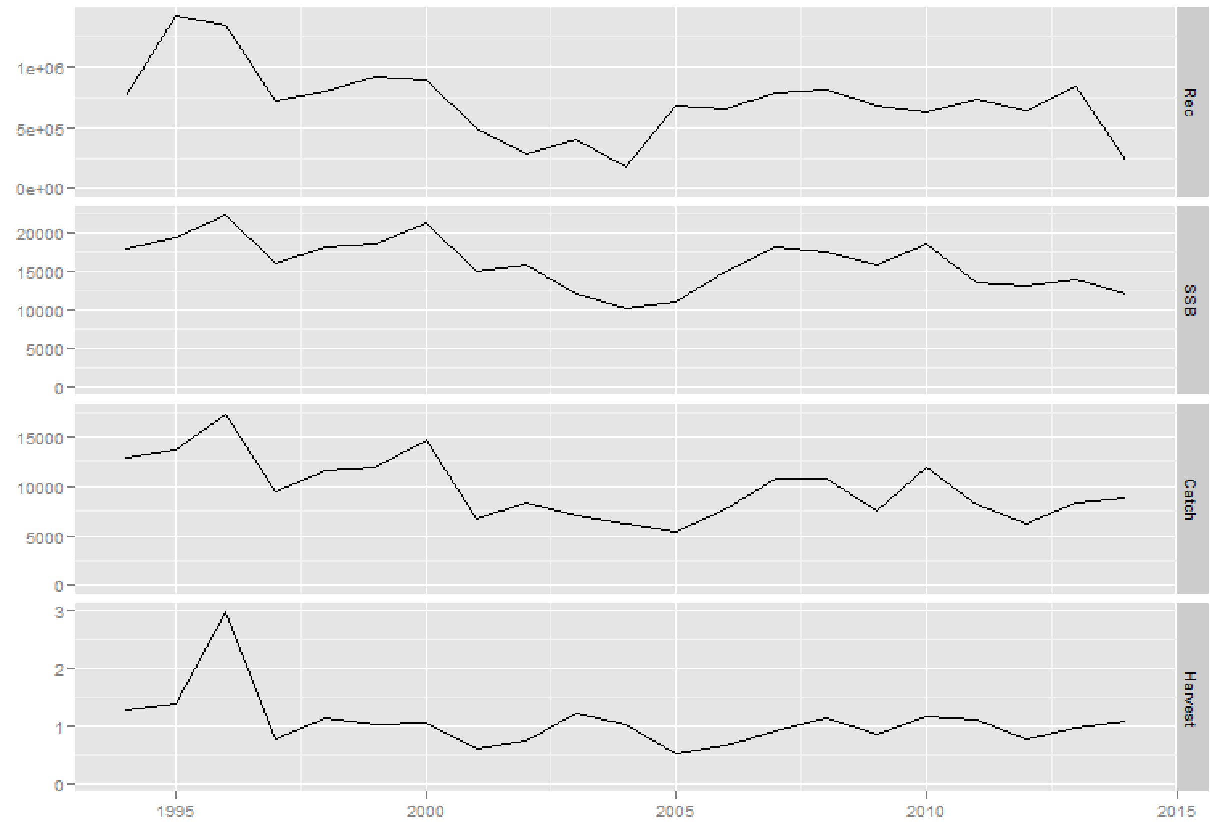
The detailed assessment can be found in section 5.2.6.

5.1.7 WHITING

Species common name: Whiting
Species scientific name *Merlangius merlangus*
Geographical Sub-area(s) GSA(s): GSA29

5.1.7.1 Stock development over time

SSB showed a slight declining trend along the time series. Recruitment has been rather stable after 2005, with a drop in the last year. After a peak in 1996, F has oscillated around 1 in the last 15 years. The current explotation rate (E = 0.32, which corresponds to an F = 1.08) is smaller than E_{MSY} (0.40, which corresponds to an F = 0.79), which indicates that whiting in GSA 29 is being fished above E_{MSY}.



Whiting in GSA 29. XSA results. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.1.7.2 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of whiting in GSA 29 in 2016 consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.1.7.3 Basis of the assessment

The state of exploitation was assessed for the period 2003-2014 applying the Extended Survivor Analysis (XSA) method calibrated with commercial CPUE from Turkey and the survey index from Romania. A vector of natural mortality (M) was obtained applying PRODBIOM.

5.1.7.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.7.5 Reference points

Table 5.1.7.5.1 Whiting in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	E_{MSY}	0.4	Patterson exploitation rate for small pelagics	STECF 2014
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.7.6 Quality of the assessment

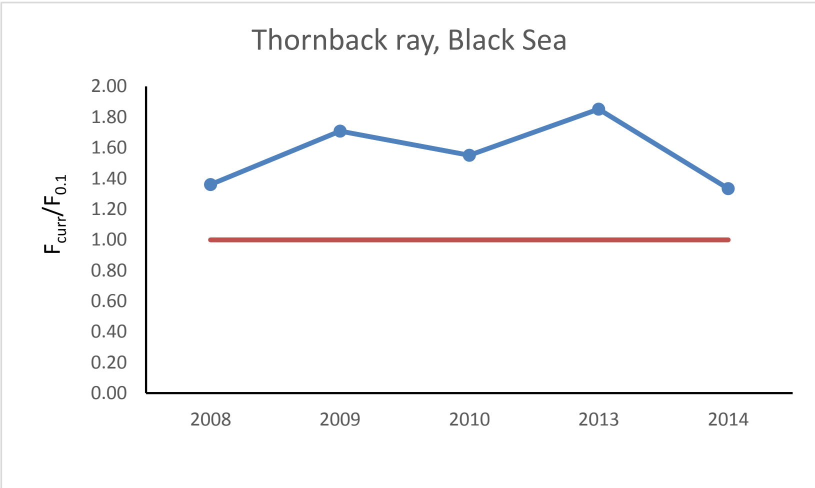
The detailed assessment can be found in section 5.2.7.

5.1.8 THORNBACK RAY

Species common name: Thornback ray
Species scientific name: *Raja clavata*
Geographical Sub-area(s) GSA(s): GSA 29

5.1.8.1 Stock development over time

Results can be viewed as being uncertain, but indicative of the status of exploitation of Thornback ray in the Black Sea. According to the F estimates obtained using pseudo-cohort analysis, F (mean value for the period 2008-2014 is equal to 0.25) has always been larger than the estimated F_{MSY} value (0.16).



Thornback ray in GSA 29. Trend of F_{curr} /$F_{0.1}$ ratio.

5.1.8.2 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level (0.16), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of Thornback ray in GSA 29 in 2016 consistent with F_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.1.8.3 Basis of the assessment

A VIT model (Pseudo cohort analisys) only considering landings from Bulgaria and Turkey for the period 2008-2014 was used. Data from Georgia, Russia, Ukraine were not available, and those from Romania were available for 2014 only. Catch numbers-at-age from Turkey were used to estimate the catch composition of Bulgarian landings.

5.1.8.4 Catch options

No short term forecast was performed as the assessment is only indicative of trends.

5.1.8.5 Reference points

Table 5.1.8.5.1 Thornback ray in GSA 29. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.16	$F_{0.1}$	Present assessment
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.8.6 Quality of the assessment

The detailed assessment can be found in section 5.2.8.

5.2 STOCK ASSESSMENT

5.2.1 STOCK ASSESSMENT OF SPRAT

5.2.1.1 Stock Identification

Due to the lack of information about the structure of sprat (*Sprattus sprattus*) population in the Black Sea, this stock was assumed to be confined within the GSA 29 boundaries (**Figure 5.2.1.1.1**).

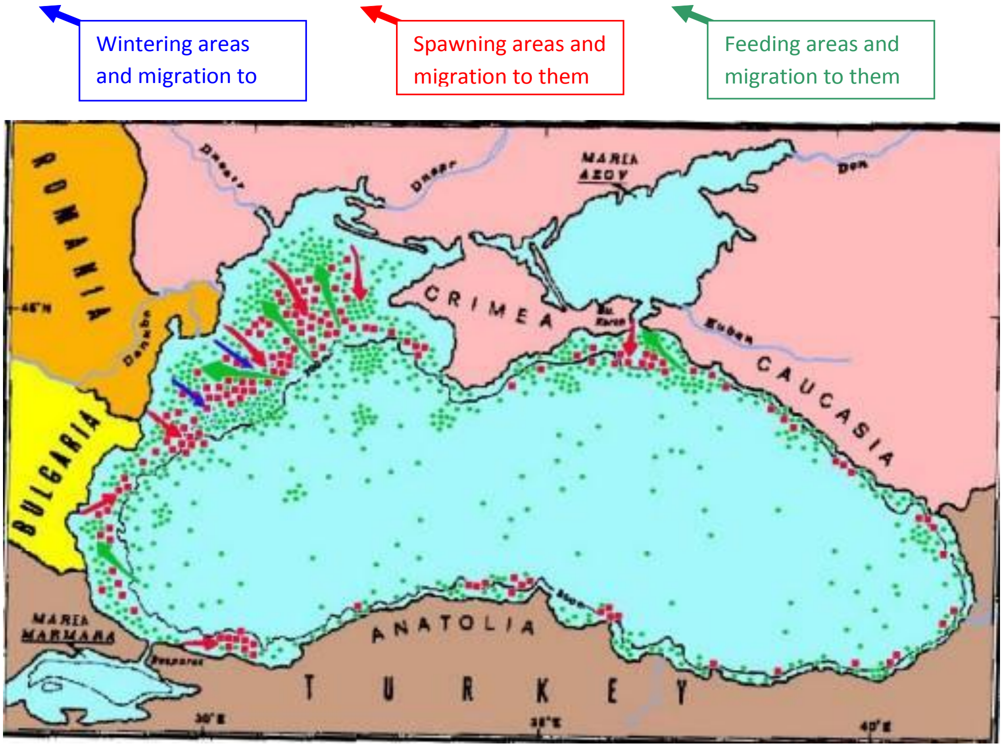


Fig. 5.2.1.1.1. Sprat distribution and migration in the Black Sea.

5.2.1.2 Growth

The species is fast growing with the population constituted by 5 age groups. The von Bertlanffy Growth Parameters VBGF by countries for 2014 is given in Table 5.2.1.2.1. In Romanian waters asymptotic length is comparable with the growth parameters derived in Bulgarian and Ukrainian Black Sea waters (Table 5.2.1.2.1). In Turkish waters the asymptotic length significantly differs for 2014.

Table 5.2.1.2.1. Sprat in GSA 29. VBGF parameters estimated in 2014.

	L_∞	K	t_0	a	b
Bulgaria	12.05	0.41	-0.01	0.0009	2.77
Romania	12.60	0.25	-1.58	0.0117	2.70
Ukraine	12.33	0.34	-0.78	0.0134	2.67
Turkey	13.69	0.32	-0.83	0.0059	2.96

5.2.1.3 Maturity

All fish (100%) are assumed to mature at the start of the first year of their life.

5.2.1.4 Natural mortality

Constant natural mortality of M=0.95 is assumed for all mature fishes based on estimations by Prodanov et al. (1995). Natural mortality of juvenile fishes, recruiting the stock in mid-year (1st of July) is estimated as M=0.64 (for the second half of the year, Prodanov et al. 1995).

Table 5.2.1.4.1. Instantaneous rate of natural mortality estimated in 2014.

	Turkey	Bulgaria	Romania	Ukraine
Natural mortality, M	0.65	1.04	0.50	0.70
Method	Pauly's formula	Gislason	Pauly's formula	Pauly's formula

5.2.1.5 Fisheries

5.2.1.5.1 General description of the fisheries

The sprat fishery is taking place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA 29). The exploitation of the fish recourses is limited to the shelf area as the water below 100-150 m is anoxic and contains hydrogen sulphide. In Bulgarian, Romanian, Russian and Ukrainian waters the most intensive fisheries for Black Sea sprat is conducted between April and October with mid-water trawls on vessels 15-40 m long and a small number of vessels >40m. Beyond the 12-mile zone a special permission is needed for fishing. Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls (Shlyakhov and Shlyakhova, 2011; Shlyakhov et al., 2012; Kumantsov and Raykov, 2012). The use of paired vessels in pelagic trawling along Yesilirmak-Kizilirmak shelf area in southern Black Sea gained importance by 1990s and became wide spread by 2000s. At present nearly 40 pairs of vessels are operating along the mentioned area. The main gears used for sprat fishery in Turkey (fishing area is constrained in front of the city of Samsun) are pelagic pair trawls working in spring at 20-40m depth and in autumn in deeper water: 40-80m depths. At the same time the Turkish pair-trawl fishermen used the same gear targeting horse mackerel and anchovy in the same area. In Turkey the total catch of sprat -as a target species- is directly transported to fish meal and oil factories as raw material (Knudsen and Zengin, 2006).

The significance of the sprat fishery in Turkey in the last years has increased and the landings reached 87 141 t in 2011. The catch of all countries reached 120 708 t. In 2012 a drastic decrease up to 35 025 has been observed. In the 2013 the total sprat landings in Turkey was at the lowest level 9 764 t. And the catch of all countries was 27 355 t. In 2014 an increase in total sprat catch has been observed. The total catch reached 58 380 t. The Turkish share was the biggest (41 648 t). It should be noted that in 2014 the political events in the Crimea prevented the normal development of fisheries in the main fishing area on the northern shelf of the Sea.

5.2.1.5.2 Management regulations applicable in 2015

A quota (Table 5.2.1.5.2.1) is allocated in EU waters of the Black Sea (Bulgaria and Romania). No fishery management agreement exists among other Black Sea countries. In the EU Black Sea waters a global (both Romania and Bulgaria) TAC of 12 750 tons has been allocated in 2009 and 2010. In 2011 and in 2012-2014 allocated quota in Bulgarian waters was at the rate of 8 032.5 t sprat (Council Regulation 5/2012) and 3 442.49 t for Romanian waters. The decreasing trend in indices since 2008 was observed despite of quotas regime in force in Community waters. Because of insufficient national funding by NDCP, hydro acoustic survey (2012 and 2014) for the assessment of sprat stocks off the Bulgarian Black Sea coast has not been carried out. Sprat (*Sprattus sprattus*) is subject to national quotas for EU member states.

Table 5.2.1.5.2.1. EC quota and recommended Total allowable catch of sprat in EU waters for 2008-2014.

Year / National data	2008	2009	2010	2011	2012	2013	2014
Species	Sprat **(SPR)**	Sprat **(SPR)**	Sprat **(SPR)**	Sprat (SPR)	Sprat (SPR)	Sprat (SPR)	Sprat (SPR)
Quota, t	15 000[2]	12 750[2]	12 750[2]	11 475[2] 8032.51	11 475[2] 8032.51	11 475[2] 8032.51	11 475[2] 8032.51
Total catch, t	4 300.0363(BG) 234 (RO)	4 541.35 (BG) 92(RO)	4 039. 966 (BG) 39(RO)	3 957.895 (BG) 131.3 (RO)	3 156.832 (BG) 87.458(RO)	3784.191 (BG) 98.84(RO)	2279.3 (BG) 84.9 (RO)
Biomass. t	32 718.33 60 000[5]	41 761.398[3] 60 000[5]	75 080.20[4] 59 600[5]	48 201.7[4] -	- 68 886	- 56 428	55 360 39 277
Recommended TAC	average 13 746.57	11 469.9[3]	12 500[4]	-	-	-	-

1. Quota according to Regulation (EU) № 1579/2007. Regulation (EU) № 1139/2008.Regulation (EU) № 1287/2009.Regulation (EU) № 1004/2010.Regulation (EU) № 1256/2010. Regulation (EU) № 5/2012
2. EC's quota
3. Source of data: Institute of Oceanology – BAS. Bulgaria
4. Source of data: Institute of Oceanology – BAS. Bulgaria and NIMRD,Romania
5. National Institute for Marine Research and Development, Romania

Current management regulations are in force for the sprat fisheries in Turkey:

(1) Regulations about fishing area: Sprat fishery by pelagic trawls should be conducted only along Samsun shelf area. The coordinates of this area were specified. But except sprat, the fishery is allowed for anchovy, horse mackerel and bluefish along other trawling areas in Black Sea.

(2) Regulations on fishing gear: In Turkey pelagic trawls operate as paired vessels. Vessels engaged in sprat fishery need to receive licence eligible only for one fishing period from Samsun City Directorate of Food, Agriculture and Livestock. The single vessel operation in pelagic fishery seems to be inconvenient for Turkey, at least for now, as the fisherman can quickly change the gear to bottom trawling during operation.

(3) Regulations about time periods: Though pelagic fishing period starts in 15 September as same as bottom trawling, it lasts up to 15th of May. Bottom trawling ends by 15th of April. There is no limitation in distance from land for pelagic trawling.

(4) Regulations about depth: The pelagic fishery is banned in waters shallower than 18 m in fishing area between 15 September and 15 April. However between 15 April – 15 May it is allowed in waters deeper than 36 m limited with offshore of Çayağzı Cape (Samsun-Yakakent) in west and Akçay estuary (Samsun – Ordu city border) in east (Anonymous, 2006). Sprat catch reaches a maximum in this one month-period and provide a great economic input for fishermen. Conversely with bottom trawling, depth limitations are in force in pelagic fishery, rather than distance from land. But as mentioned above the depth limitation is increased to 36 m by 15 April in order to protect spawning adults and juveniles in the coastal zone.

Table 5.2.1.5.2.2. Sprat total TAC (in thousands of tons) applied to vessels of Ukraine and Russian Federation.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Russian Federation	42			21	21	21				
Ukraine	60	70	40	50	50	50	60	70	70	*)

*) A TAC was not set in Ukraine in 2014.

Table 5.2.1.5.2.3. Minimum landing size of sprat in GSA 29. Legend: TL – total length; SL – standard length.

	BG	GE	RO	RU	TR	UA
Sprattus sparttus	TL=7cm	SL=6cm	TL=7cm	SL= 6cm	NO	SL=6cm

5.2.1.5.3 Catches

Catch and landings of sprat in the Black Sea were reported by all Black Sea countries. Mid-water trawl (OTM) catches dominate the landings.

5.2.1.5.4 Landings

There was a significant increase in catches in Turkey and Russian Federation in 2014. At the same time, the logistics problems linked to the political events in the Crimea prevented the increase of sprat catches in Ukraine. In Romania and Bulgaria the catches of sprat were low in 2014.

Table 5.2.1.5.4.1. Sprat in GSA 29. Landings in tonnes.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine with Crimea	Total
1970	1407		2678			353	4438
1971	2473		2517			846	5836
1972	2962		23	16		884	3885
1973	3383		22	22		878	4305
1974	4468		1245	23		477	6213

1975	5565		731	43		787	7126
1976	7199		161	16		1594	8970
1977	8754		1463	2354		4346	16917
1978	10596	1	149	3317		1949	16012
1979	13541	3466	2269	17700		36757	73733
1980	16568	4571	989	14687		47635	84450
1981	1888	5781	2283	20165		49175	79292
1982	16524	2462	3004	15266		3862	41118
1983	12023	886	3406	3843		20755	40913
1984	13921	847	4456	5270		18021	42515
1985	15924	1817	6836	3365		23657	51599
1986	1169	2939	8979	7010		33147	53244
1987	10979	697	9474	8972		43158	73280
1988	6199	7172	6454	7157		39835	66817
1989	7403	9708	8911	16045		63239	105306
1990	2651	6895	3198	6955		33174	52873
1991	1909	2313	729	2675		11094	18720
1992	2353	830	2074	3221		11492	19970
1993	2174	32	2439	694	940	9154	15433
1994	2200	308	2203	1013	933	12615	19272
1995	2874	288	1982	1263	1639	15218	23264
1996	3535	185	2014	1537	1608	20720	29599
1997	3646	85	3318	706	500	20208	28463
1998	3275	24	3293	1243	1500	30282	39617
1999	3595	45	1933	4473	965	29238	40249
2000	1737	42	1803	5543	6225	32644	47994
2001	695	40	1792	11122	1000	48938	63587
2002	11595	34	1617	11218	2050	45430	71944
2003	9155	2	1219	204	6025	31366	47971
2004	2889	12	135	143	5411	30891	39481
2005	2575	19	1487	1316	5500	35707	46604
2006	2655		492	8157	7311	21308	39923
2007	2559		208	6077	11921	18013	38778
2008	4304		234	7814	39303	21111	72766
2009	4551		92	8744	53385	24603	91375
2010	4041		39	5839	57023	24652	91594
2011	3958		131	5099	87141	24379	120708
2012	3157		88	3937	12092	15751	35025
2013	3784		99	842	9764	12866	27355
2014	2279		85	5577	41648	8791	58380

5.2.1.5.5 Discards

No discards of sprat have been reported with the exception of Romania, which were estimated to be around 15 tons in 2014. Discards are considered to be negligible and thus they were not included in the assessment.

5.2.1.5.6 Fishing effort

Under DCF 199/2008 Bulgaria, for 2014 reported 36 vessels operating with OTM with nominal effort of 7002 kW and GT of 1823 t. Turkey reported 82 vessels with nominal effort of 2,339,943 kW and fishing of 39,008 hrs. In Ukraine, the data were available only for the most western part of the economic zone and territorial waters. Only seven vessels with nominal effort of 1544 kW has operated in this area in recent years.

5.2.1.6 Scientific surveys

5.2.1.6.1 Survey #1 **Bulgarian hydro acoustic survey**

5.2.1.6.1.1 Methods

Acoustic survey in 2014 covers partially the territorial waters and EEZ of Bulgaria in FAO GSA 29 – Black Sea. The study area includes continental shelf and slope up to 200 m depth. Total investigated area amounts approximately to 2630 NM^2. A parallel transect design is adopted with transects running perpendicular to the coastline and lines of bathymetry with inter-transect distance of 5 nm. The vessel speed is adjusted depending on the vessel noise at 6.5-7.5 knots. Time for acoustic sampling was Day time & Night time. The minimum echo sounding depth was 20 m and the maximum – 200 m.

5.2.1.6.1.2 Geographical distribution

Sprat schools were found scattered over the most of the surveyed area, predominantly in the deeper waters after 50 m isobaths. Only in front of the area between Varna and Kamchia River mouth, sprat agglomerations were observed in the shallow waters at depths between 20 and 50m. The main sprat concentrations were found in front of Kaliakra-Shabla and between Varna and Ahtopol, forming a layer between 50 and 100 m depths with NASC values range between 7.80-28.51 ($m^2.nm^{-2}$). The point map of distribution of sprat NASC values ($m^2.nm^{-2}$) obtained during the acoustic survey of R/V "Akademik" in October-November 2014 is presented on the Figure 5.2.1.6.1.2.1.

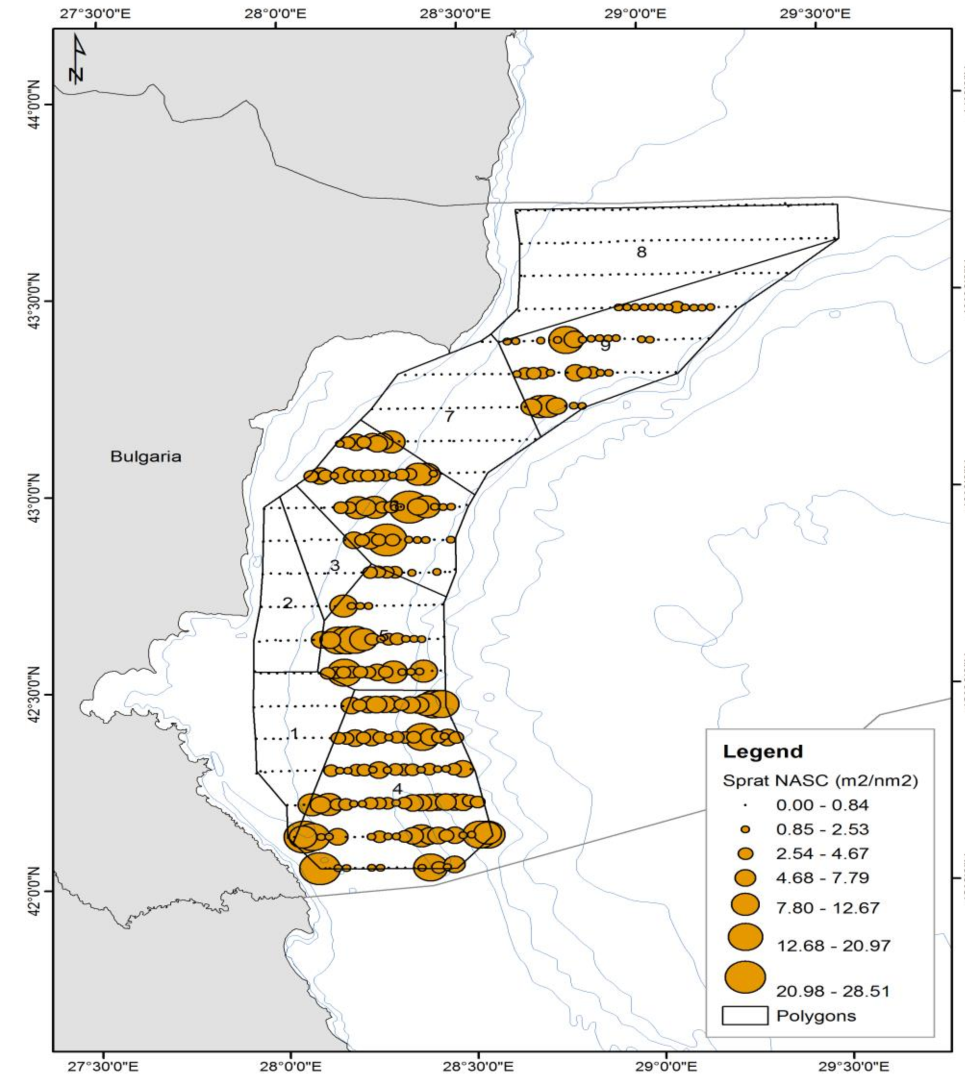


Figure 5.2.1.6.1.2.1. Point map of sprat NASC values ($m^2.nm^{-2}$) as estimated by the Bulgarian hydro acoustic survey.

5.2.1.6.1.3 Trends in abundance and biomass

The distribution of sprat abundance (numbers, millions) and relative biomass (tonnes) by age groups and polygons as estimated by the Bulgarian hydro acoustic survey are presented on Table 5.2.1.6.1.3.1 and 5.2.1.6.1.3.2.

Table 5.2.1.6.1.3.1. Abundance of sprat (millions) by age groups and polygons as estimated by the Bulgarian hydro acoustic survey, October-November 2014 (Panayotova et al., 2015).

Polygon	Total (millions)	Age (millions)				
		1	2	3	4	5
3	297		198	99		
4	7294	47	3867	2877	472	31
5	2400	295	1125	860	121	
6	2878	1104	1032	674	68	
9	2427	884	1323	220		

Total	15296	2329	7545	4730	660	31

Table 5.2.1.6.1.3.2. Biomass (t) of sprat by age groups and polygons as estimated by the Bulgarian hydro acoustic survey, October-November 2014 (Panayotova et al., 2015).

Polygon	Total (t)	Age				
		1	2	3	4	5
3	1225		817	408		
4	23205	150	12303	9152	1500	100
5	9619	1181	4508	3448	483	
6	12385	4751	4440	2901	292	
9	8926	3251	4867	808		
Total (t)	55360	9333	26934	16718	2275	100

5.2.1.6.1.4 Trends in abundance by length or age

Size structure of sprat catches during the survey encompasses fish with total lengths between 6.5 and 11.5 cm. The most abundant size classes were between 7.5 cm and 9.5 cm (Figure 5.2.1.6.1.4.1), which corresponds to age groups 1-3 (Figure 5.2.1.6.1.4.2). The average length of all measured fish over all hauls was estimated at 8.69 cm.

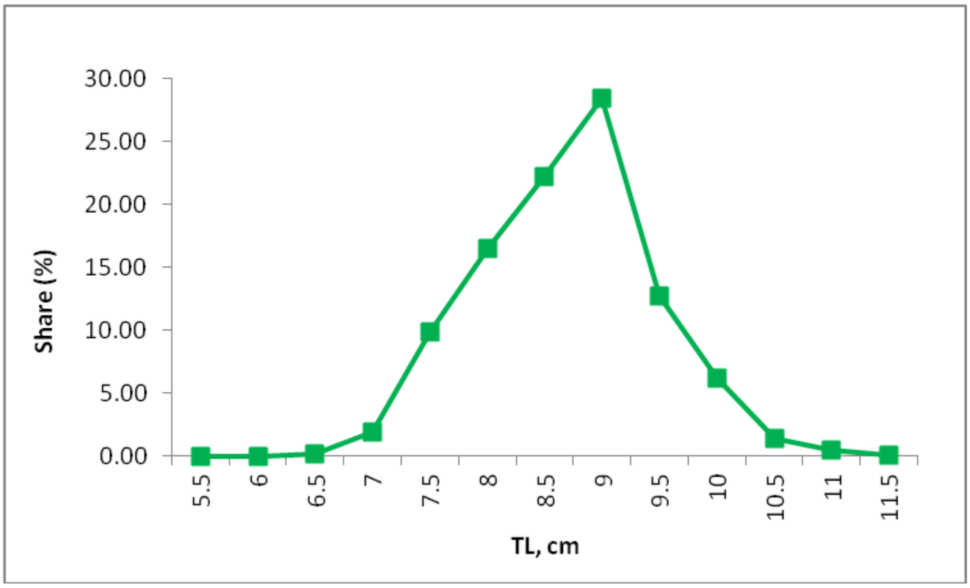


Figure 5.2.1.6.1.4.1. Length frequency distribution of sprat as estimated by the Bulgarian hydro acoustic survey.

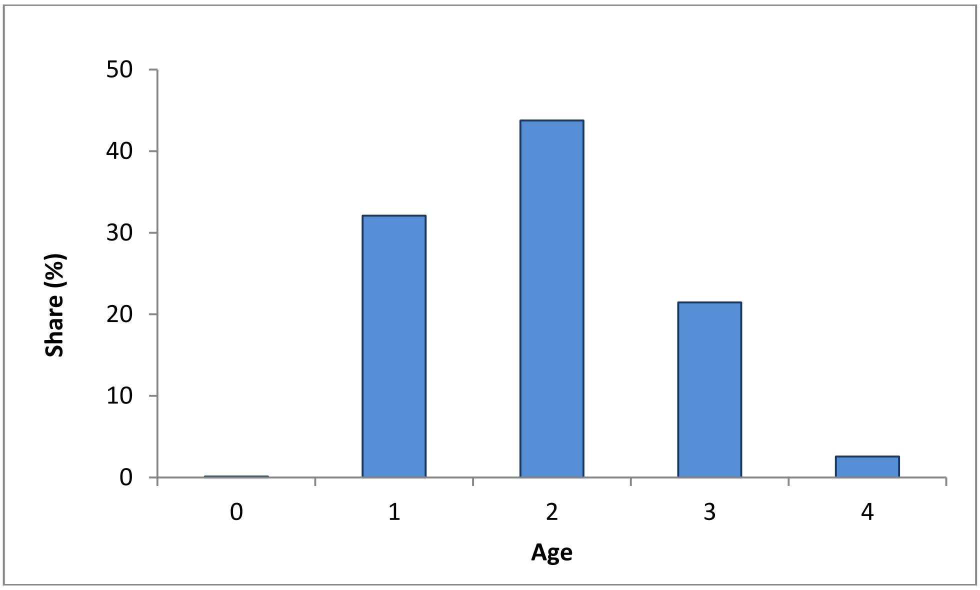


Figure 5.2.1.6.1.4.2. Age structure of sprat as estimated by the Bulgarian hydro acoustic survey.

5.2.1.6.2 *Survey #2* Romanian mid-water trawl survey

5.2.1.6.2.1 Methods

The survey was realized in the 3th Quarter 2014, in Romanian waters. The pelagic trawl 57/63-62 m, with horizontal opening of 22 m was used. The average speed of the vessel was of 2.5 knots. The trawling time was standardized at 60 minutes; 30 hauls were realized. The analysis of data obtained by sweeping area procedures conducted with pelagic trawl reveals a low average of sprat catches 7.85 t /Nm^2.

5.2.1.6.2.2 Geographical distribution

The survey was conducted at depths between 13.8 m and 62 m and covered almost entirely the continental shelf of the Romanian coast, between St. Gheorghe and Vama Veche.

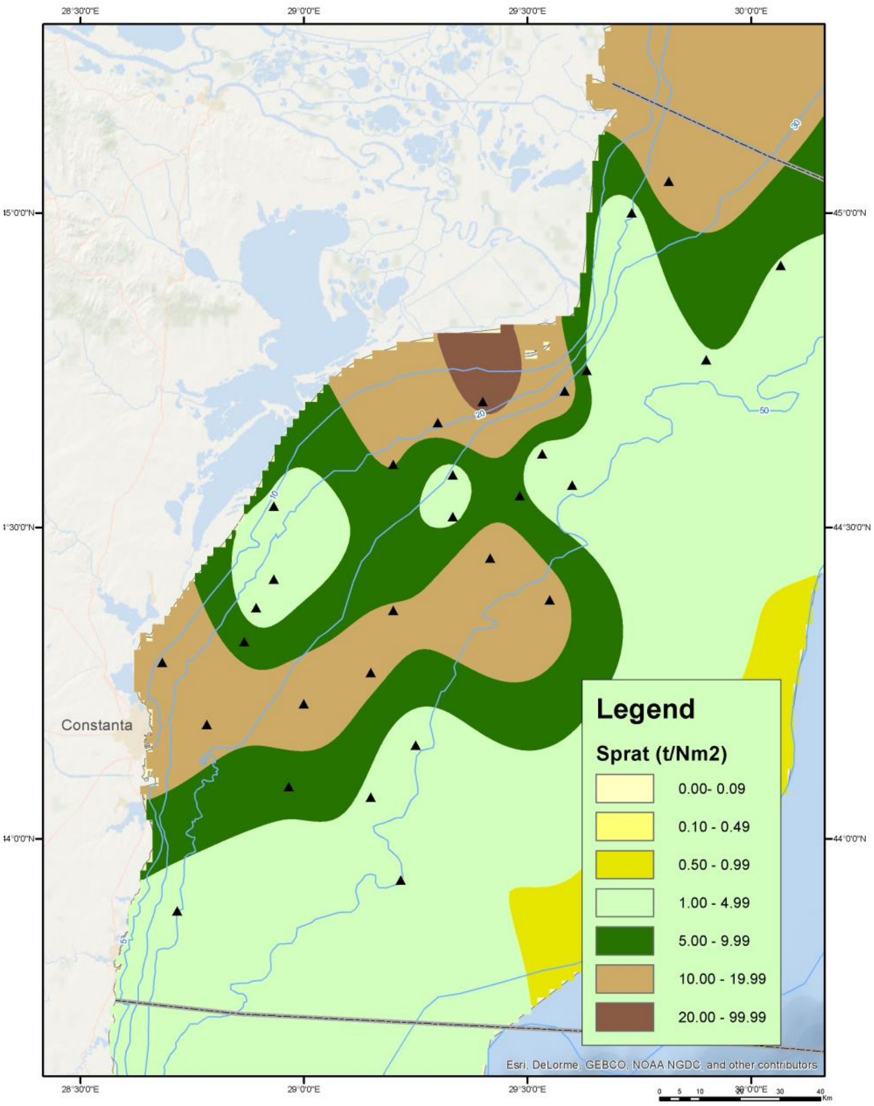


Figure 5.2.1.6.2.2.1. Distribution of the sprat abundance in the 3rd Quarter 2014 in Romanian marine waters as estimated by the Romanian hydro acoustic survey.

5.2.1.6.2.3 Trends in abundance and biomass

Estimated biomass of sprat in the investigated area was of about 12 569 tonnes, and the estimated one for the entire Romanian platform up to distance of 50 nm, was about 39 277 tones.

Table 5.2.1.6.2.3.1. Sprat biomass as estimated by the Romanian and Bulgarian hydro acoustic survey for 2008-2014.

	2008	2009	2010	2011	2012	2013	2014
Bulgarian waters	32718	41761	75080	48202	-	-	55 361
Romanian waters	60000	60000	59600	-	68886	56428	39277

5.2.1.6.2.4 Trends in abundance by length or age

Age composition of catches indicates the presence of 1-3 years old individuals. Most of the individuals caught are 1 years old (87.0%), followed by those of 2 years (11.0%) and 3 years (2%) (Figure 5.2.1.6.2.4.1).

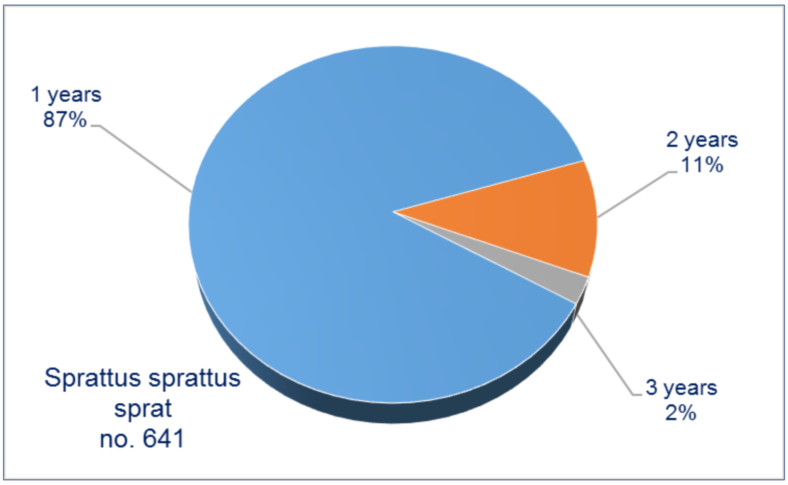


Figure 5.2.1.6.2.4.1. Structure by age composition of sprat as estimated by the Romanian hydro acoustic survey.

5.2.1.7 Stock Assessment

5.2.1.7.1 Methods

Catch-at-age Analysis (ICA; Patterson and Melvin. 1996) was used to assess the stock of sprat in GSA 29. ICA is a statistical catch-at-age method based on the Fournier and Deriso models (Deriso et al., 1985). It applies a statistical optimization procedure to calculate population numbers and fishing mortality coefficients-at-age from data of catch numbers-at-age and natural mortality. The dynamics of a cohort (generation) in the stock are expressed by two non-linear equations referred to as a survival equation (exponential decay) and a catch equation:

$$N_{a+1.y+1} = N_{a.y} * exp(-F_{a.y} - M).$$
$$C_{a.y} = N_{a.y} * [1 - exp(-F_{a.y} - M)] * F_{a.y} / (F_{a.y} + M)$$

where C, N, M and F are catch, abundance, natural mortality, and fishing mortality, while a and y are subscript indices for age and year.

The algorithm initially estimates population numbers and fishing mortality fitting a separable model. when F is assumed to conform to a constant selection pattern (fishing mortality-at-age). but fishing mortality by year is allowed to vary. The F matrix is then modelled as a multiplication of the year-specific F and the specified selection pattern. This procedure substantially diminishes the number of parameters in the model.

In its second stage. the ICA algorithm minimizes the weighted Sum of Square Residuals (SSR) of observed and modelled catch and relative abundance indices (CPUE), assuming Gaussian distribution of the log residuals:

$$min\ [\sum_{\boldsymbol{a.y}} pc_{a.y} (log\ C_{a.y} - log\ \hat{C}_{a.y})^2 + \sum_{\boldsymbol{a.y.f}} pi_{a.f} (log\ I_{a.y.f} - log\ \hat{I}_{a.y.f})^2$$

where C, Ĉ, I, and Î are observed and estimated catch and age-structured index, respectively, and a, y, and f are subscript indices for age, year and fleet. Weights associated with catches and different indices (pc, pi) are ideally set equal to the inverse variances of catch and index data and can be calculated based on the residuals between modelled and observed values. However, weights are usually set by the user on the basis of some information about the reliability of different indices and current experience with modelling the stock. Indices are defined as related to population numbers by the equations:

$\hat{I}_{a.y} = N_{a.y} * exp(-F_{a.y} - M)$
$\hat{I}_{a.y} = q_a * N_{a.y} * exp(-F_{a.y} - M)$
$\hat{I}_{a.y} = q_a * (N_{a.y} * exp(-F_{a.y} - M))^{k}{}_{a}$

The two unknown parameters (qa. an age-specific catchability, and k, a constant) are estimated according to the assumed relationship between the population and the abundance index, which has to be specified as being one of the above – identity, linear or power, respectively.

ICA combines the power and accuracy of a statistical model with the flexibility of setting different options of the parameters (e.g. a separable model accounting for age effects) and for this reason is suitable for a short living species (age 5 at maximum) such as the Black Sea sprat. ICA has previously been applied to Black Sea sprat by Daskalov (1998) and Daskalov et al. 2010, 2011, and 2012.

5.2.1.7.2 Input data

Catch and weight at age, natural mortality, and 5 age structured fish abundance indices were used to run ICA (Table 5.2.1.7.2.1). Total catch at age data were compiled by summing catch at age matrices from Bulgaria, Romania, Russia, Turkey and Ukraine. Catch at age matrix from Russia was derived by applying age composition and mean weight in the catch of Ukraine to Russia catch. 5 age structured indices were used for deriving the ICA estimates: CPUE from Bulgarian, Ukrainian and Turkish commercial sprat fleets and relative fish abundance indices from the Romanian Pelagic Trawl Survey(RPTS), and Bulgarian Acoustic survey (BAS).

Table 5.2.1.7.2.1. Sprat in GSA 29. ICA input data.

SPRAT 2014

Catch in Number

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	21.	108.	278.	236.	1009.	406.	809.	415.	1202.	445.	528.	1158.	3180.	1299.	1558.
1	1712.	2496.	2741.	2278.	3838.	4877.	10352.	6829.	5654.	6878.	6024.	5976.	5351.	7774.	12266.
2	2792.	2773.	2600.	2831.	3086.	3340.	6646.	7655.	5454.	3580.	4652.	2705.	1876.	3248.	7833.
3	418.	579.	830.	1741.	1302.	1313.	1269.	3090.	3024.	2666.	1602.	785.	802.	1327.	3278.
4	13.	17.	43.	82.	121.	110.	109.	182.	674.	278.	372.	92.	113.	168.	369.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

x 10 ^ 6

Catch in Number

AGE	2010	2011	2012	2013	2014
0	2934.	2581.	3861.	1811.	2415.
1	7940.	10080.	4468.	5009.	2832.
2	7120.	12677.	2882.	3129.	6577.
3	4378.	8236.	1106.	588.	2296.
4	316.	377.	97.	37.	372.
5	6.	14.	0.	15.	7.

x 10 ^ 6

Predicted Catch in Number

AGE	2009	2010	2011	2012	2013	2014

0	2318.	2504.	4569.	3157.	972.	2415.
1	10906.	6642.	10139.	5452.	3604.	4369.
2	7971.	11696.	8930.	4255.	2559.	6615.
3	3309.	3394.	5384.	1192.	885.	2211.
4	339.	332.	387.	113.	52.	203.

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	.002500	.002500	.002300	.002400	.002800	.002300	.001700	.001800	.001700	.001900	.002100	.002000	.001700	.002300	.002400
1	.003800	.003800	.003300	.004000	.003200	.003500	.002500	.002700	.002800	.002900	.003500	.003300	.003300	.003400	.003100
2	.004600	.005200	.004900	.005100	.005000	.004500	.004000	.004100	.004000	.004400	.004700	.004300	.004900	.004300	.004000
3	.005400	.006000	.006300	.007600	.006500	.006000	.006300	.005800	.006100	.006000	.006200	.006000	.007200	.005200	.004900
4	.006900	.007400	.007200	.009400	.007300	.007800	.006900	.007700	.006800	.007300	.007700	.007300	.008700	.007000	.006000
5	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the catches (Kg)

AGE	2010	2011	2012	2013	2014
0	.002100	.002100	.001600	.001800	.001600
1	.002900	.002700	.002200	.002100	.002900
2	.004400	.003700	.004200	.003300	.005100
3	.006500	.004600	.005500	.005000	.005800
4	.008000	.008700	.007100	.006800	.006400
5	.016000	.010000	.010000	.010000	.008000

Weights at age in the stock (Kg)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000
1	.003300	.002800	.002700	.003400	.002500	.003200	.003500	.003600	.003500	.003400	.003600	.003600	.003600	.003100	.003100
2	.004300	.004300	.004700	.004600	.004700	.004400	.004400	.004500	.004400	.004400	.004600	.004600	.004700	.004200	.004100
3	.004800	.004700	.005700	.006400	.005900	.005600	.005200	.006100	.005900	.006000	.006100	.005700	.006300	.005600	.004700
4	.005500	.005300	.006900	.008200	.007300	.007200	.006700	.007400	.007400	.007200	.007400	.007400	.007600	.007000	.005400
5	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the stock (Kg)

AGE	2010	2011	2012	2013	2014
0	.001000	.001000	.001000	.001000	.001000
1	.002500	.003000	.002600	.001600	.002400
2	.003500	.004000	.003900	.004100	.003600
3	.004500	.004800	.005500	.004800	.005000
4	.007100	.007300	.007900	.008000	.006700
5	.016000	.010000	.010000	.010000	.000000

Natural Mortality (per year)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000

Natural Mortality (per year)

AGE	2010	2011	2012	2013	2014
0	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000

Proportion of fish spawning

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2010	2011	2012	2013	2014
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Bul

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	19.59	41.06	53.32	52.36	101.06	106.86	103.05	74.39	56.86	65.51	42.09	40.59	57.25	79.25	66.13
2	48.77	38.16	28.37	58.52	30.60	76.34	71.10	71.11	49.82	44.34	27.74	21.64	32.98	71.84	57.91
3	7.36	9.45	6.21	5.28	4.54	6.95	4.03	23.08	14.35	15.94	9.36	4.21	10.17	51.88	19.69
4	0.23	0.59	0.61	0.54	0.30	0.67	0.23	1.25	2.57	3.93	0.94	1.30	1.73	5.16	3.16

x 10 ^ 3

Bul

AGE	2010	2011	2012	2013	2014
1	63.39	40.34	105.34	122.17	86.42
2	69.21	44.02	50.49	59.55	66.91
3	53.15	32.18	9.83	11.10	21.73
4	6.08	4.77	2.10	0.14	2.38

x 10 ^ 3

Ukr

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	80.94	111.12	58.09	59.67	97.40	222.49	193.27	158.30	76.22	125.47	113.57	180.31	127.15	284.84	*******
2	103.68	118.27	50.40	68.14	85.43	146.35	118.28	179.30	76.02	46.40	88.14	69.18	24.19	55.49	143.30
3	9.43	9.43	10.52	46.52	37.49	66.40	22.53	76.56	47.52	54.76	29.98	24.67	16.90	37.53	37.47
4	0.14	0.66	0.72	2.36	0.56	6.10	2.15	4.65	10.87	5.06	8.06	2.52	0.10	3.07	0.66

x 10 ^ 3

Ukr

AGE	2010	2011	2012	2013	2014
1	*******	253.76	188.67	161.04	85.43
2	67.33	70.76	*******	80.10	141.40
3	4.84	14.37	20.49	*******	38.30
4	0.24	0.11	2.35	0.37	11.78

x 10 ^ 3

Rom survey

AGE	2007	2008	2009	2010	2011	2012	2013	2014
1	20571.	72155.	53939.	999990.	999990.	79615.	45054.	62464.
2	26498.	40969.	72325.	999990.	999990.	39609.	19760.	42466.
3	14120.	11359.	14361.	999990.	999990.	11247.	3118.	24329.

BG acoustic

AGE	2011	2012	2013	2014
1	1968.0	*******	*******	1798.0
2	2522.0	*******	*******	2451.0
3	894.0	*******	*******	1202.0
4	43.0	*******	*******	144.0

TUR cpue

AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	51.90	25.37	17.92	24.58	38.37	104.84	53.74	55.26	*******	21.27	22.26	34.69
2	32.96	61.65	12.98	19.23	23.07	60.14	54.39	109.54	*******	35.91	21.80	*******
3	13.64	3.71	4.53	3.22	6.41	17.90	30.40	75.52	*******	14.86	6.30	*******
4	4.17	0.22	0.49	0.14	1.26	2.95	4.43	5.32	*******	1.01	0.50	0.36

x 10 ^ 3

5.2.1.7.3 Results

ICA was run assuming a constant selection pattern in 2008-2014 (Fig. 5.2.1.7.3.2, Table 5.2.1.7.3.1) with reference F at age 2 and Selection at the last ‘real’ age (S4) equal to 1.

The results of the ICA show a reasonable fit to observation data (Fig. 5.2.1.7.3.3. Fig. 5.2.1.7.3.4. Fig. 5.2.1.7.3.5). Fitting to RPTS and BAS data are not shown as they cover only few years (2 years in the case of BAS). The overall fit and partial SSR converged to unique minima (Fig. 5.2.1.7.3.1). Retrospective analyses show no systematic deviations (Fig. 5.2.1.7.3.6).

Analyses of the main population parameters (abundance, catch, fishing mortality, Fig. 5.2.1.7.3.7 Table 5.2.1.7.3.1.) indicate that the sprat stock has recovered from the depression in the 1990s due to good recruitment in 1999-2001 and the biomass and catches have gradually increased over the 1990s and during the 2000s reached levels comparable to the previous periods of high abundance. The stock estimates reveal the cyclic nature of sprat population dynamics. The years with strong recruitment were followed by years of low to medium recruitment which leads to corresponding changes in the Spawning Stock Biomass (SSB). High fishing mortalities ($F_{1\text{-}3}$) were observed in early 1990s, 2004-2005 and 2010-2012. In 2011 the highest ever total catch of 120 708t (Table 5.2.1.7.3.1) was recorded mainly due to the intensive development of the Turkish sprat fishery. Over 2007-2010 period the levels of biomass and catches were comparable with the highest figures reported, but in 2009-2011 a decreasing trend in recruitment becomes evident (Fig. 5.2.1.7.3.7A). In 2012-2013 catches dropped more than 3 times, and SSB is estimated at the level of about 200 000t. The last year (2014) catch and biomass show some increase reflecting the positive influence of the relatively strong year-class 2012 (Fig. 5.2.1.7.3.7).

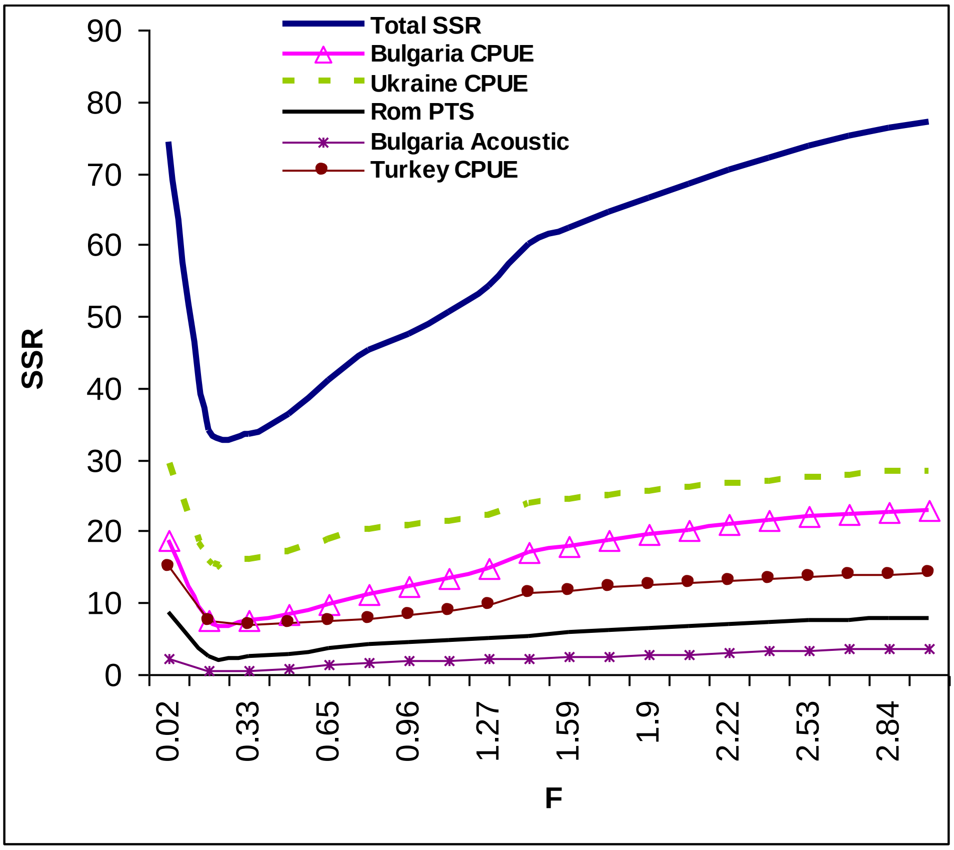


Fig. 5.2.1.7.3.1. Sprat in GSA 29. Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the reference F from the ICA final model.

Fig. 5.2.1.7.3.2. Sprat in GSA 29. Selection pattern estimated by the separable ICA model.

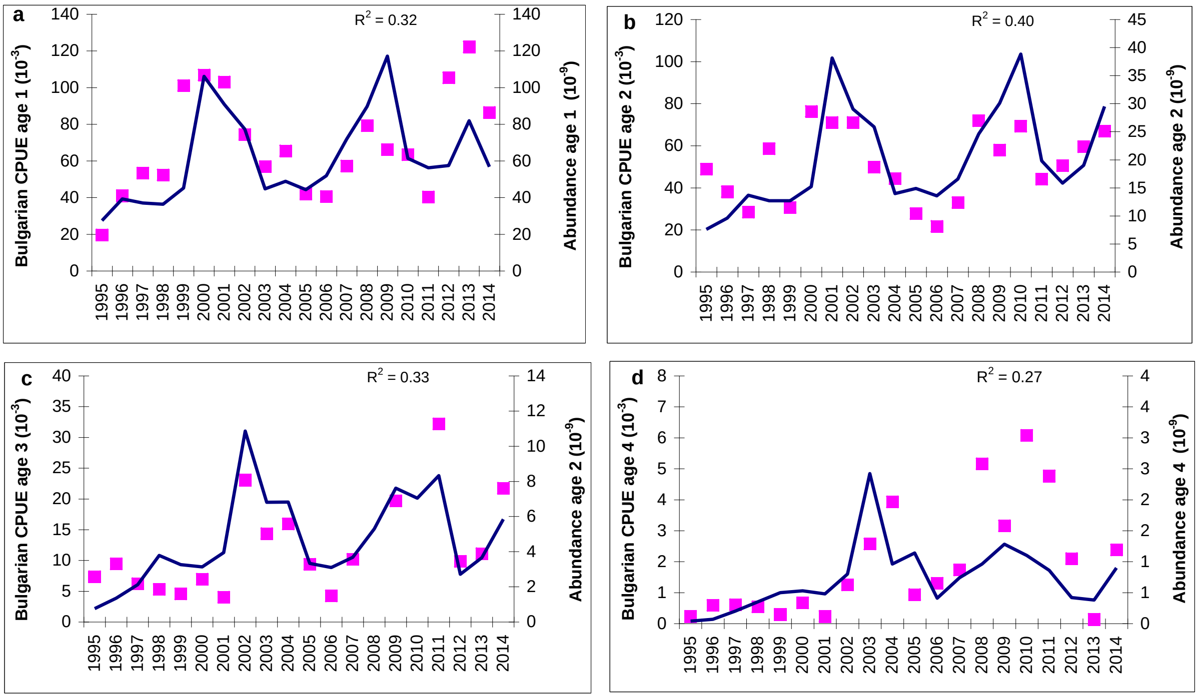


Fig. 5.2.1.7.3.3. Sprat in GSA 29. Time-series of estimated and observed abundance-at-age and age-structured Bulgarian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

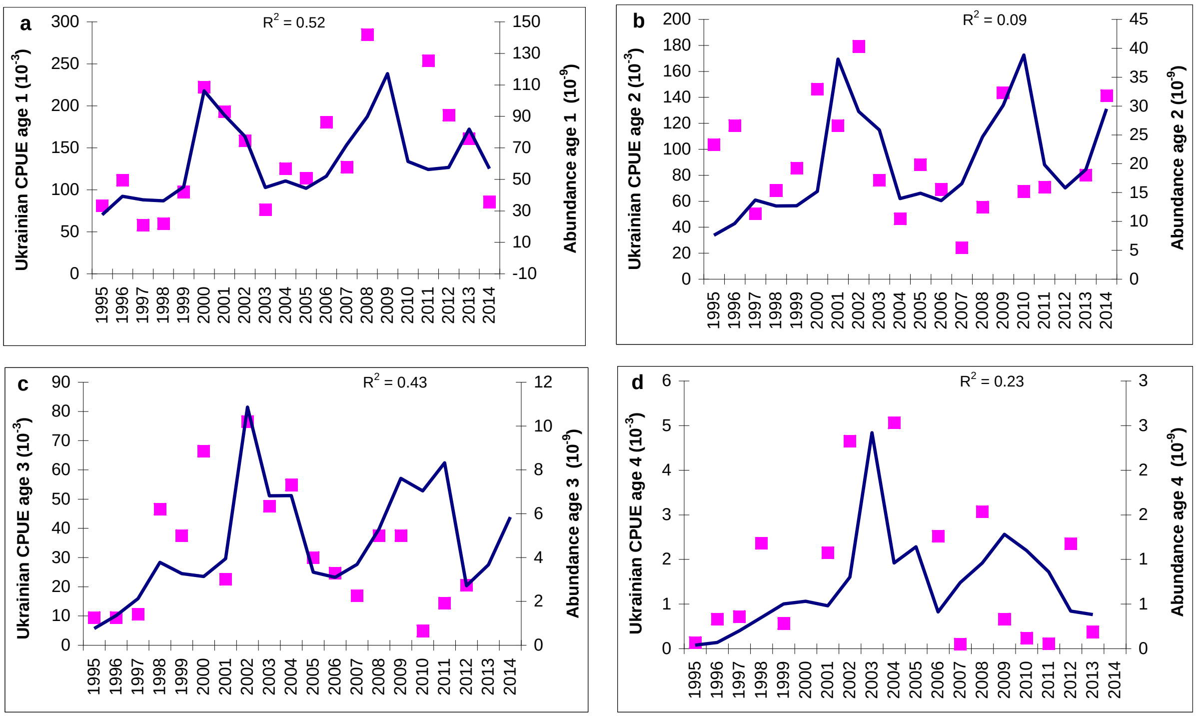


Figure 5.2.1.7.3.4. Sprat in GSA 29. Time-series of estimated and observed abundance-at-age and age-structured Ukrainian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

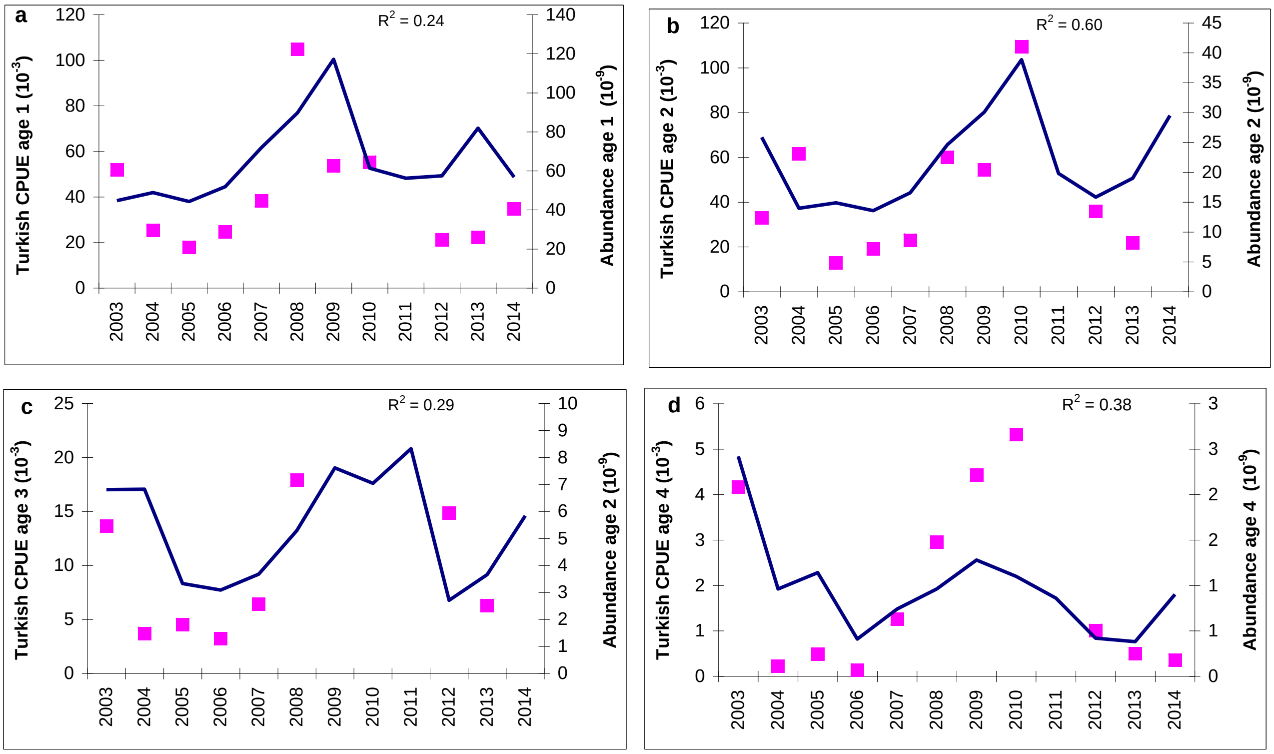


Figure 5.2.1.7.3.5. Sprat in GSA 29. Time-series of estimated and observed abundance-at-age and age-structured Turkish CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

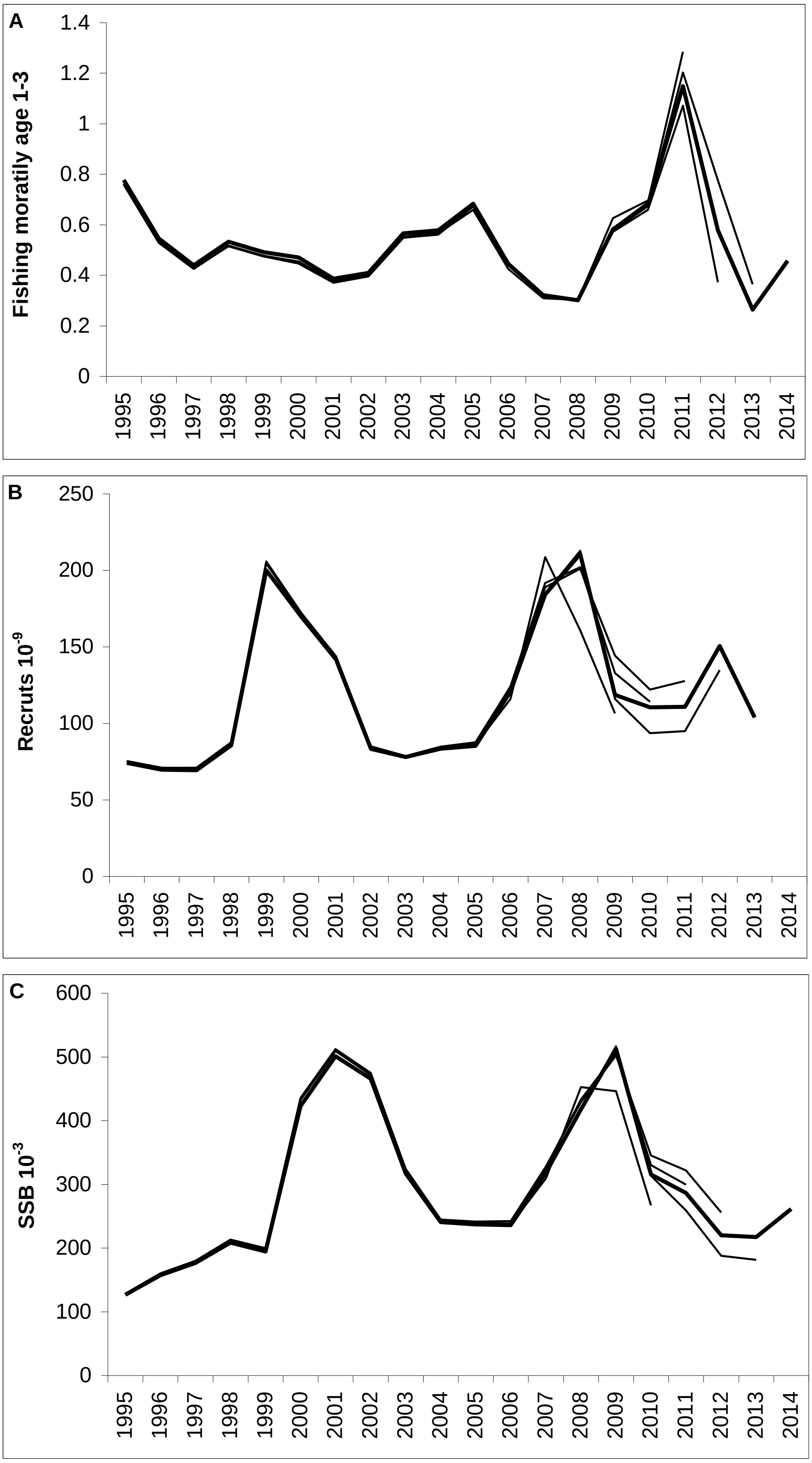


Figure 5.2.1.7.3.6. Sprat in GSA 29. Retrospective analyses.

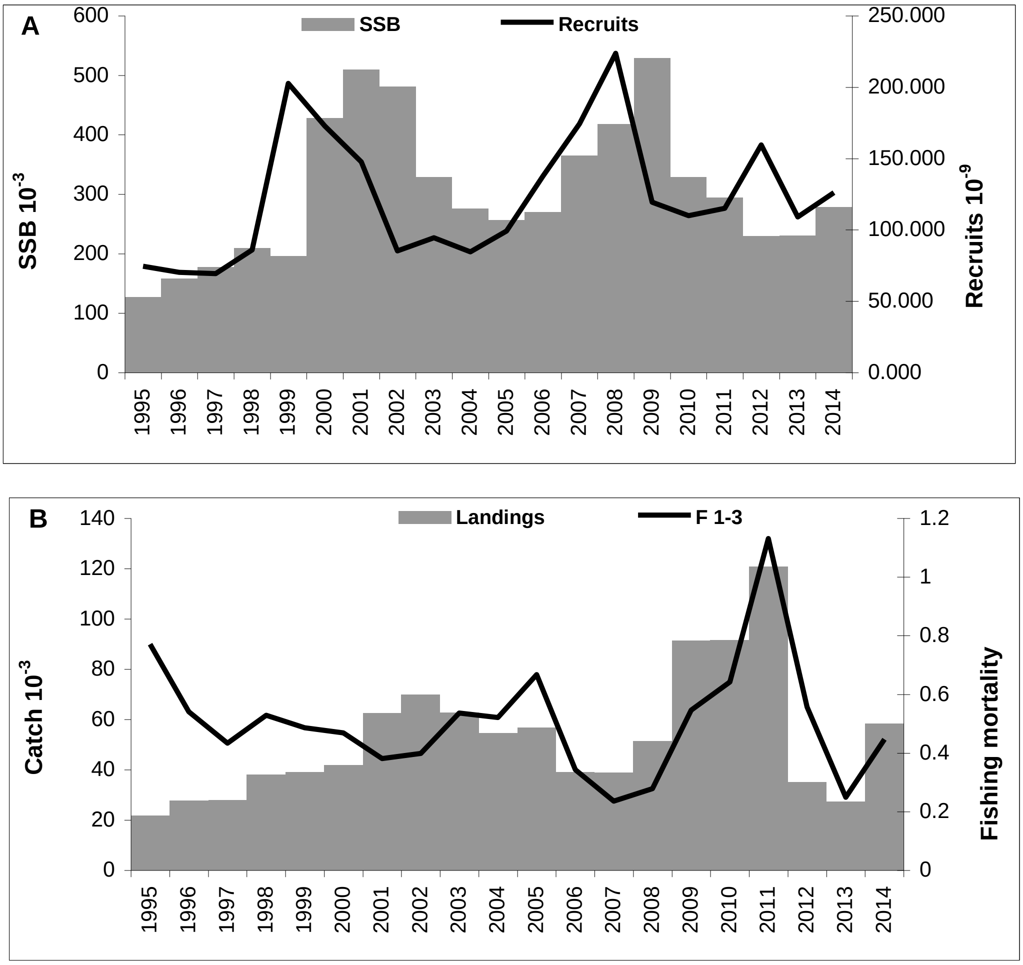


Fig. 5.2.1.7.3.7. Sprat in GSA 29. Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 1-3 line).

Table 5.2.1.7.3.1. Sprat in GSA 29. ICA results and diagnostics.

Fishing Mortality (per year)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.0004	0.0021	0.0055	0.0037	0.0068	0.0032	0.0074	0.0066	0.0174	0.0071	0.0072	0.0114	0.0250	0.0079	0.0266
1	0.1008	0.1029	0.1207	0.1013	0.1395	0.0734	0.1910	0.1454	0.2140	0.2406	0.2319	0.1933	0.1213	0.1424	0.1538
2	0.7724	0.5601	0.3378	0.4081	0.4517	0.4006	0.3061	0.4995	0.3818	0.4825	0.6202	0.3569	0.1901	0.2241	0.5022
3	1.4379	0.9582	0.8414	1.0757	0.8662	0.9326	0.6445	0.5492	1.0138	0.8394	1.1508	0.4768	0.3970	0.4698	0.9824
4	0.6122	0.4620	0.3874	0.4296	0.4500	0.3724	0.4198	0.4183	0.5329	0.5657	0.6553	0.4107	0.2630	0.3098	0.5022
5	0.6122	0.4620	0.3874	0.4296	0.4500	0.3724	0.4198	0.4183	0.5329	0.5657	0.6553	0.4107	0.2630	0.3098	0.5022

Fishing Mortality (per year)

AGE	2010	2011	2012	2013	2014
0	0.0313	0.0551	0.0271	0.0121	0.0217
1	0.1808	0.3184	0.1569	0.0702	0.1256
2	0.5905	1.0399	0.5124	0.2294	0.4103
3	1.1551	2.0340	1.0022	0.4487	0.8025
4	0.5905	1.0399	0.5124	0.2294	0.4103
5	0.5905	1.0399	0.5124	0.2294	0.4103

Population Abundance (1 January)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	74.42	70.30	69.31	86.01	202.61	172.86	147.69	85.37	94.38	84.57	99.10	137.90	174.44	223.83	119.44
1	27.44	39.23	36.99	36.35	45.19	106.11	90.86	77.30	44.72	48.91	44.28	51.88	71.89	89.71	117.10
2	7.58	9.60	13.69	12.68	12.70	15.20	38.13	29.03	25.85	13.96	14.87	13.58	16.54	24.63	30.09
3	0.76	1.35	2.12	3.78	3.26	3.13	3.94	10.86	6.81	6.82	3.33	3.09	3.68	5.29	7.61
4	0.04	0.07	0.20	0.35	0.50	0.53	0.48	0.80	2.42	0.96	1.14	0.41	0.74	0.96	1.28
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 9

Population Abundance (1 January)

AGE	2010	2011	2012	2013	2014	2015
0	109.96	115.14	159.48	108.98	152.00	153.63
1	61.33	56.19	57.46	81.84	56.77	78.43
2	38.83	19.79	15.81	18.99	29.50	19.36
3	7.04	8.32	2.71	3.66	5.84	7.57
4	1.10	0.86	0.42	0.38	0.90	1.01
5	0.02	0.03	0.00	0.11	0.03	0.24

x 10 ^ 9

Weighting factors for the catches in number

AGE	2009	2010	2011	2012	2013	2014
0	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Bul Predicted

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	30.84	44.03	41.16	40.83	49.80	120.88	97.59	84.94	47.48	51.24	46.60	55.66	79.96	98.73	128.14
2	17.07	24.03	38.31	34.27	33.59	41.23	108.44	74.94	70.78	36.36	36.14	37.65	49.83	72.96	77.58
3	1.74	3.92	6.50	10.30	9.88	9.17	13.33	38.55	19.17	20.96	8.76	11.39	14.08	19.54	21.76
4	0.08	0.16	0.46	0.79	1.11	1.23	1.07	1.81	5.17	2.01	2.29	0.92	1.81	2.28	2.77

x 10 ^ 3

Bul Predicted

AGE	2010	2011	2012	2013	2014
1	66.21	56.63	62.78	93.38	63.00
2	95.79	39.00	40.54	56.13	79.64
3	18.47	14.06	7.66	13.67	18.27
4	2.28	1.42	0.91	0.95	2.05

x 10 ^ 3

Ukr Predicted

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	65.67	93.77	87.64	86.95	106.05	257.42	207.82	180.89	101.12	109.13	99.23	118.53	170.27	210.25	*******
2	29.08	40.94	65.26	58.37	57.21	70.24	184.72	127.66	120.56	61.93	61.56	64.13	84.89	124.29	132.14
3	3.78	8.51	14.12	22.37	21.45	19.90	28.95	83.72	41.64	45.50	19.02	24.72	30.58	42.42	47.25
4	0.10	0.18	0.53	0.92	1.28	1.41	1.24	2.08	5.97	2.31	2.64	1.07	2.09	2.63	3.19

x 10 ^ 3

Ukr Predicted

AGE	2010	2011	2012	2013	2014
1	*******	120.60	133.69	198.85	134.17
2	163.16	66.44	*******	95.61	135.67
3	40.10	30.53	16.63	*******	39.67
4	2.63	1.64	1.05	1.10	2.37

x 10 ^ 3

Rom survey Predicted

AGE	2007	2008	2009	2010	2011	2012	2013	2014
1	48196.	59514.	77239.	999990.	999990.	37841.	56286.	37977.
2	30345.	44428.	47237.	999990.	999990.	24687.	34177.	48496.
3	10494.	14558.	16217.	999990.	999990.	5709.	10188.	13614.

BG acoustic Predicted

AGE	2011	2012	2013	2014
1	1783.5	*******	*******	1984.0
2	1739.9	*******	*******	3552.8
3	909.4	*******	*******	1181.6
4	65.5	*******	*******	94.6

TUR cpue Predicted

AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	24618.	26568.	24158.	28857.	41454.	51189.	66434.	34327.	999990.	32548.	48412.	32664.
2	46571.	23921.	23779.	24772.	32791.	48009.	51045.	63026.	999990.	26677.	36932.	999990.
3	13867.	15155.	6335.	8234.	10183.	14128.	15738.	13356.	999990.	5540.	9887.	999990.
4	2751.	1067.	1216.	492.	964.	1212.	1473.	1215.	999990.	482.	507.	1091.

Fitted Selection Pattern

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.0005	0.0037	0.0161	0.0091	0.0150	0.0079	0.0243	0.0132	0.0455	0.0148	0.0117	0.0320	0.1313	0.0352	0.0529
1	0.1305	0.1837	0.3573	0.2482	0.3087	0.1833	0.6241	0.2911	0.5604	0.4987	0.3739	0.5418	0.6380	0.6354	0.3062
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.8617	1.7110	2.4904	2.6357	1.9177	2.3283	2.1057	1.0996	2.6550	1.7398	1.8554	1.3362	2.0882	2.0960	1.9560
4	0.7926	0.8249	1.1467	1.0527	0.9962	0.9296	1.3715	0.8376	1.3958	1.1726	1.0566	1.1507	1.3836	1.3822	1.0000
5	0.7926	0.8249	1.1467	1.0527	0.9962	0.9296	1.3715	0.8376	1.3958	1.1726	1.0566	1.1507	1.3836	1.3822	1.0000

Fitted Selection Pattern

AGE	2010	2011	2012	2013	2014
0	0.0529	0.0529	0.0529	0.0529	0.0529
1	0.3062	0.3062	0.3062	0.3062	0.3062
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.9560	1.9560	1.9560	1.9560	1.9560
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 3	SoP (%)
1995	74422430	201475	127053	21746	0.1712	1.1052	100
1996	70304630	228150	157845	27778	0.1760	0.7592	99
1997	69308790	246991	177682	27963	0.1574	0.5896	100
1998	86012820	294985	208972	38117	0.1824	0.7419	99
1999	202609270	398150	195540	39152	0.2002	0.6589	98
2000	172863270	600640	427776	41769	0.0976	0.6666	100
2001	147689910	657154	509464	62587	0.1228	0.4753	100
2002	85366930	566423	481057	69894	0.1453	0.5243	99
2003	94375520	422761	328386	62716	0.1910	0.6978	99
2004	84573290	360116	275543	54574	0.1981	0.6609	100
2005	99103050	355670	256567	56854	0.2216	0.8855	100
2006	137903570	407781	269877	39048	0.1447	0.4169	100
2007	174442610	539765	365323	39008	0.1068	0.2935	99
2008	223832030	641687	417855	51463	0.1232	0.3470	99
2009	119443170	648497	529054	91376	0.1727	0.7423	100
2010	109956680	439007	329050	91594	0.2784	0.8728	99
2011	115136780	409414	294278	120710	0.4102	1.5369	99
2012	159477590	388721	229244	35025	0.1528	0.7573	100
2013	108978320	339537	230559	27268	0.1183	0.3391	99
2014	152004850	429725	277720	58357	0.0210	0.6064	9

No of years for separable analysis : 6

```
 Age range in the analysis : 0  . . . 5
 Year range in the analysis : 1995  . . . 2014
 Number of indices of SSB : 0
 Number of age-structured indices : 5

 Parameters to estimate : 38
 Number of observations : 254

 Conventional single selection vector model to be fitted.



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 PARAMETER ESTIMATES

 iParm.i      i Maximum i    i        i         i         i         i Mean of i
 i No. i      i Likelh. i CV i  Lower i Upper   i  -s.e.  i   +s.e. i Param.  i
 i     i      i Estimatei (%)i 95% CL i 95% CL  i         i         i Distrib.i
 Separable model : F by year
    1   2009     0.5022  21    0.3327    0.7581    0.4071    0.6197    0.5134
    2   2010     0.5905  19    0.4034    0.8645    0.4862    0.7173    0.6018
    3   2011     1.0399  16    0.7470    1.4474    0.8784    1.2310    1.0548
    4   2012     0.5124  20    0.3445    0.7620    0.4184    0.6274    0.5230
    5   2013     0.2294  23    0.1456    0.3615    0.1819    0.2893    0.2357
    6   2014     0.4103  27    0.2412    0.6979    0.3129    0.5380    0.4256

 Separable Model: Selection (S) by age
    7      0     0.0529  29    0.0296    0.0945    0.0394    0.0712    0.0553
    8      1     0.3062  21    0.2008    0.4670    0.2469    0.3798    0.3134
           2     1.0000     Fixed : Reference Age
    9      3     1.9560  16    1.4127    2.7084    1.6568    2.3093    1.9832
           4     1.0000     Fixed : Last true age

 Separable model: Populations in year 2014
   10      0  152004858  67   40619515 568826997  77526096 298034829 190676351
   11      1   56769713  27   32796503  98266582  42908230  75109141  59038275
   12      2   29503990  21   19464924  44720720  23862921  36478579  30175788
   13      3    5840161  18    4091006   8337186   4870235   7003250   5937276
   14      4     904193  20     606363   1348309    737439   1108654    923178

Separable model: Populations at age
   15   2009    1278485  30     697441   2343604    938460   1741709   1341080
   16   2010    1102187  23     696364   1744512    871989   1393155   1132852
   17   2011     857982  23     542920   1355876    679327   1083620    881689
   18   2012     420899  25     255880    692339    326514    542567    434689
   19   2013     384163  23     244055    604705    304783    484217    394593



 Age-structured index catchabilities
                                       Bul

 Linear model fitted. Slopes at age :
   20   1  Q  .1900E-02  17 .1605E-02 .3198E-02 .1900E-02 .2701E-02 .2301E-02
   21   2  Q  .5329E-02  17 .4503E-02 .8957E-02 .5329E-02 .7569E-02 .6450E-02
   22   3  Q  .7513E-02  17 .6344E-02 .1266E-01 .7513E-02 .1069E-01 .9101E-02
   23   4  Q  .4478E-02  17 .3769E-02 .7617E-02 .4478E-02 .6412E-02 .5445E-02


                                       Ukr

 Linear model fitted. Slopes at age :
   24   1  Q  .4047E-02  18 .3389E-02 .6991E-02 .4047E-02 .5855E-02 .4951E-02
   25   2  Q  .9078E-02  17 .7640E-02 .1545E-01 .9078E-02 .1300E-01 .1104E-01
   26   3  Q  .1631E-01  18 .1372E-01 .2780E-01 .1631E-01 .2339E-01 .1985E-01
   27   4  Q  .5164E-02  17 .4346E-02 .8784E-02 .5164E-02 .7394E-02 .6279E-02


                                       Rom survey

 Linear model fitted. Slopes at age :
   28   1  Q  .1145E-02  28 .8697E-03 .2678E-02 .1145E-02 .2033E-02 .1590E-02
   29   2  Q  .3245E-02  28 .2471E-02 .7518E-02 .3245E-02 .5725E-02 .4487E-02
   30   3  Q  .5599E-02  28 .4252E-02 .1308E-01 .5599E-02 .9933E-02 .7770E-02


                                       BG acoustic

 Linear model fitted. Slopes at age :
   31   1  Q  .5984E-04  57 .3447E-04 .3277E-03 .5984E-04 .1888E-03 .1254E-03
   32   2  Q  .2377E-03  56 .1378E-03 .1278E-02 .2377E-03 .7408E-03 .4932E-03
   33   3  Q  .4860E-03  56 .2813E-03 .2622E-02 .4860E-03 .1518E-02 .1010E-02
   34   4  Q  .2064E-03  57 .1185E-03 .1143E-02 .2064E-03 .6561E-03 .4350E-03


                                       TUR cpue

 Linear model fitted. Slopes at age :
   35   1  Q  .9852E-03  23 .7831E-03 .2000E-02 .9852E-03 .1590E-02 .1288E-02
   36   2  Q  .3506E-02  24 .2764E-02 .7305E-02 .3506E-02 .5758E-02 .4634E-02
   37   3  Q  .5433E-02  24 .4277E-02 .1136E-01 .5433E-02 .8943E-02 .7191E-02
   38   4  Q  .2381E-02  24 .1882E-02 .4914E-02 .2381E-02 .3885E-02 .3134E-02


 RESIDUALS ABOUT THE MODEL FIT
 ------------------------------

       Separable Model Residuals
       -------------------------
------+------------------------------------------------
Age   |    2009    2010    2011    2012    2013    2014
------+------------------------------------------------
  0   | -0.3973  0.1585 -0.5712  0.2014  0.6220  0.0000
  1   |  0.1176  0.1785 -0.0059 -0.1991  0.3293 -0.4334
  2   | -0.0174 -0.4964  0.3504 -0.3897  0.2013 -0.0058
  3   | -0.0095  0.2547  0.4250 -0.0750 -0.4088  0.0378
  4   |  0.0861 -0.0485 -0.0266 -0.1564 -0.3283  0.6066
------+------------------------------------------------



 AGE-STRUCTURED INDEX RESIDUALS
 -------------------------------

       Bul
       ---
```

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	-0.454	-0.070	0.259	0.249	0.708	-0.123	0.054	-0.133	0.180	0.246	-0.102	-0.316	-0.334	-0.220	-0.661
2	1.050	0.462	-0.300	0.535	-0.093	0.616	-0.422	-0.052	-0.351	0.199	-0.265	-0.554	-0.413	-0.015	-0.292
3	1.443	0.880	-0.046	-0.669	-0.777	-0.277	-1.195	-0.513	-0.290	-0.273	0.066	-0.995	-0.326	0.977	-0.100
4	1.036	1.330	0.276	-0.383	-1.316	-0.603	-1.537	-0.367	-0.701	0.673	-0.892	0.343	-0.046	0.816	0.131

Bul

Age	2010	2011	2012	2013	2014
1	-0.044	-0.339	0.518	0.269	0.316
2	-0.325	0.121	0.219	0.059	-0.174
3	1.057	0.828	0.250	-0.208	0.174
4	0.979	1.212	0.842	-1.933	0.149

Ukr

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.209	0.170	-0.411	-0.377	-0.085	-0.146	-0.073	-0.133	-0.283	0.140	0.135	0.420	-0.292	0.304	*******
2	1.271	1.061	-0.258	0.155	0.401	0.734	-0.446	0.340	-0.461	-0.289	0.359	0.076	-1.255	-0.806	0.081
3	0.915	0.103	-0.294	0.732	0.558	1.205	-0.251	-0.089	0.132	0.185	0.455	-0.002	-0.593	-0.123	-0.232
4	0.358	1.308	0.307	0.946	-0.832	1.463	0.554	0.803	0.600	0.783	1.117	0.858	-3.040	0.155	-1.575

Ukr

Age	2010	2011	2012	2013	2014
1	*******	0.744	0.344	-0.211	-0.451
2	-0.885	0.063	*******	-0.177	0.041
3	-2.115	-0.753	0.208	*******	-0.035
4	-2.387	-2.728	0.811	-1.095	1.606

Rom survey

Age	2007	2008	2009	2010	2011	2012	2013	2014
1	-0.851	0.193	-0.359	*******	*******	0.744	-0.223	0.498
2	-0.136	-0.081	0.426	*******	*******	0.473	-0.548	-0.133
3	0.297	-0.248	-0.122	*******	*******	0.678	-1.184	0.581

BG acoustic

Age	2011	2012	2013	2014
1	0.0985	*******	*******	-0.0985
2	0.3712	*******	*******	-0.3712
3	-0.0171	*******	*******	0.0171
4	-0.4207	*******	*******	0.4207

TUR cpue

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.746	-0.046	-0.299	-0.160	-0.077	0.717	-0.212	0.476	*******	-0.426	-0.777	0.060
2	-0.346	0.947	-0.605	-0.253	-0.352	0.225	0.063	0.553	*******	0.297	-0.527	*******
3	-0.017	-1.406	-0.335	-0.940	-0.462	0.237	0.658	1.732	*******	0.986	-0.450	*******
4	0.415	-1.579	-0.909	-1.264	0.267	0.888	1.100	1.476	*******	0.740	-0.016	-1.114

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2009 to 2014

Variance	0.2129
Skewness test stat.	0.1155
Kurtosis test statistic	-0.7032
Partial chi-square	0.1643
Significance in fit	0.0000
Degrees of freedom	11

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Bul

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0294	0.0429	0.1295	0.2249
Skewness test stat.	0.2221	1.6554	0.7095	-0.7878
Kurtosis test statisti	-0.4574	0.1701	-0.6161	-0.7319

Partial chi-square	0.0505	0.0786	0.2755	0.6466
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	20	20	20	20
Degrees of freedom	19	19	19	19
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Ukr

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0269	0.1018	0.1260	0.5117
Skewness test stat.	0.8791	0.1445	-1.9767	-1.7990
Kurtosis test statisti	-0.4020	-0.2016	2.2042	-0.3256
Partial chi-square	0.0390	0.1655	0.2245	1.3135
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	18	19	19	20
Degrees of freedom	17	18	18	19
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Rom survey

Linear catchability relationship assumed

Age	1	2	3
Variance	0.1161	0.0498	0.1576
Skewness test stat.	-0.1414	0.0497	-0.7709
Kurtosis test statisti	-0.5964	-0.5680	-0.2634
Partial chi-square	0.0542	0.0239	0.0860
Significance in fit	0.0000	0.0000	0.0001
Number of observations	6	6	6
Degrees of freedom	5	5	5
Weight in the analysis	0.3333	0.3333	0.3333

DISTRIBUTION STATISTICS FOR BG acoustic

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0048	0.0689	0.0001	0.0885
Skewness test stat.	0.0000	0.0000	-0.0001	0.0000
Kurtosis test statisti	-0.5774	-0.5774	-0.5774	-0.5774
Partial chi-square	0.0006	0.0088	0.0000	0.0203
Significance in fit	0.0202	0.0749	0.0037	0.1133
Number of observations	2	2	2	2
Degrees of freedom	1	1	1	1
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR TUR cpue

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0563	0.0638	0.2182	0.2782
Skewness test stat.	0.4047	0.6879	0.4860	-0.2836
Kurtosis test statisti	-0.5162	-0.5260	-0.3736	-0.9390
Partial chi-square	0.0535	0.0556	0.2103	0.4034
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	11	10	10	11
Degrees of freedom	10	9	9	10
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	121.3895	254	38	216	0.5620
Catches at age	2.8105	30	19	11	0.2555
Aged Indices					
Bul	32.4295	80	4	76	0.4267
Ukr	57.1180	76	4	72	0.7933
Rom survey	4.8523	18	3	15	0.3235
BG acoustic	0.6495	8	4	4	0.1624
TUR cpue	23.5296	42	4	38	0.6192

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.9893	254	38	216	0.0462
Catches at age	2.3423	30	19	11	0.2129
Aged Indices					
Bul	2.0268	80	4	76	0.0267
Ukr	3.5699	76	4	72	0.0496
Rom survey	0.5391	18	3	15	0.0359
BG acoustic	0.0406	8	4	4	0.0101
TUR cpue	1.4706	42	4	38	0.0387

5.2.1.8 Reference points

5.2.1.8.1 Methods

Patterson's (1992) precautionary exploitation rate of E=0.4 is used to evaluate the status of the stock.

5.2.1.9 Data quality

The quality of data for sprat stock assessment in 2015 is considered acceptable to perform a reliable assessment and the short term forecast. However, EWG 15-12 has noted a trend of decreasing data quality over the last years. On one hand, data are missing for Russian and Georgia. On the other hand, the quality of national data such as age composition, and commercial CPUE is decreasing and an hydroacoustic survey covering the entire black Sea is lacking.

5.2.1.10 Short term predictions 2015-2017

5.2.1.10.1 Method

A deterministic short term prediction of stock size and catch was conducted based on ICA results.

5.2.1.10.2 Input parameters

The input parameters are listed in the Table 6.1.5.2.1 below. They do represent short term averages of the ICA inputs. The exploitation pattern used is the 2014 estimated vector rescaled to the average exploitation patterns estimated for the years 2011-2013. Recruitment was estimated as the geometric mean from 2012-2014.

As the fishery for sprat in the Black Sea is not constrained by an international TAC, F in 2015 was assumed equal to F in 2014.

Table 5.2.1.10.2.1. Sprat in GSA 29. Input to short term prediction. M for age 1 refers to 6 months as sprat spawns the 1st of June, annual natural mortality is 1.28.

2015						
age	stock size (1000s)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	126016211	0.64	0.0	0.001	0.022	0.002
1	65346089	0.95	1.0	0.002	0.126	0.003
2	19130409	0.95	1.0	0.004	0.410	0.005
3	7656895	0.95	1.0	0.005	0.803	0.006
4	1014041	0.95	1.0	0.007	0.410	0.006
5	233600	0.95	1.0	0.010	0.410	0.008
2016						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	126016211	0.64	0.0	0.001	0.022	0.002
1		0.95	1.0	0.002	0.126	0.003
2		0.95	1.0	0.004	0.410	0.005
3		0.95	1.0	0.005	0.803	0.006
4		0.95	1.0	0.007	0.410	0.006
5		0.95	1.0	0.010	0.410	0.008

2017						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	126016211	0.64	0.0	0.001	0.022	0.002
1		0.95	1.0	0.002	0.126	0.003
2		0.95	1.0	0.004	0.410	0.005
3		0.95	1.0	0.005	0.803	0.006
4		0.95	1.0	0.007	0.410	0.006
5		0.95	1.0	0.010	0.410	0.008

5.2.1.10.3 Results

Table 5.2.1.10.3.1 Sprat in GSA 29. Single option (status quo) short term prediction.

2015	F-factor:	1	reference F_{1-3}	0.45		1st January	
age	F	catch in numbers (1000s)	catch in weight (t)	stock size (1000s)	stock biomass (t)	sp. stock size (1000s)	sp. stock biomass (t)
0	0.022	1999218	3199	126016211	126016	0	0
1	0.126	5028093	14581	65346089	156831	65346089	156831
2	0.410	4289618	21877	19130409	68869	19130409	68869
3	0.803	2898452	16811	7656895	38284	7656895	38284
4	0.410	227379	1455	1014041	6794	1014041	6794
5	0.410	52380	419	233600	2336	233600	2336
		14495140	58342	219397246	399130	93381034	273114
2016	F-factor:	1	reference F_{1-3}	0.45		1st January	
age	F	catch in numbers (1000s)	catch in weight (t)	stock size (1000s)	stock biomass (t)	sp. stock size (1000s)	sp. stock biomass (t)
0	0.022	1999218	3199	126016211	126016	0	0
1	0.126	5003139	14509	65021785	156052	65021785	156052
2	0.410	4997860	25489	22288955	80240	22288955	80240
3	0.803	1858100	10777	4908577	24543	4908577	24543
4	0.410	297609	1905	1327248	8893	1327248	8893
5	0.410	58342	467	260188	2602	260188	2602
		14214268	56346	219822964	398346	93806753	272330
2017	F-factor:	1	reference F_{1-3}	0.45		1st January	
age	F	catch in numbers (1000s)	catch in weight (t)	stock size (1000s)	stock biomass (t)	sp. stock size (1000s)	sp. stock biomass (t)
0	0.022	1999218	3199	126016211	126016	0	0
1	0.126	5003139	14509	65021785	156052	65021785	156052
2	0.410	4973056	25363	22178338	79842	22178338	79842
3	0.803	2164883	12556	5719013	28595	5719013	28595
4	0.410	190787	1221	850854	5701	850854	5701
5	0.410	76362	611	340552	3406	340552	3406
		14407445	57459	220126753	399612	94110542	273596

Under the status quo F assumption catches are expected to stay at the level of 56 000- 58 000 in 2015-2017.

Fishing at F_{MSY} (0.64, corresponding to an exploitation rate of 0.40) would correspond to catches of 75 960 t in 2016 and 72 106 t in 2017. On the other hand, fishing at *status quo* F, catches are predicted to increase from 56 357 t in 2016 to 57 459 t in 2017.

5.2.1.11 Medium term predictions

5.2.1.11.1 Method

Not conducted.

5.2.1.12 Stock advice

STECF EWG 15-12 advises that catches in 2016 shoud be no more than 75,960 tonnes, which corresponds to the E_{MSY} level (0.40).

Table 5.2.1.12.1. Sprat in the Black Sea. Management option table providing short term prediction.

		2015					2016				2017	
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock bioma	catch in weight	stock biomass	sp. stock bioma	catch
1.0000	0.4461	399130	273114	58342	0.0000	0.0000	398346	272330	0	436970	310954	0
					0.1000	0.0446	398346	272330	6504	432575	306559	7970
					0.2000	0.0892	398346	272330	12790	428349	302333	15313
					0.3000	0.1338	398945	272929	18865	425404	299388	22088
					0.4000	0.1749	398945	272929	24744	421450	295434	28349
					0.5500	0.2404	398945	272929	33209	415788	289772	36879
					0.6000	0.2623	398945	272929	35943	413969	287953	39515
					0.7000	0.3123	398945	272929	41282	410427	284411	44498
					0.8000	0.3569	398945	272929	46456	407008	280992	49128
					0.9000	0.4015	398945	272929	51476	403704	277688	53441
				Fsq	**1.0000**	**0.4461**	**398346**	**272330**	**56346**	**399612**	**273596**	**57459**
					1.1000	0.4907	398945	272929	61074	397424	271408	61209
					1.2000	0.5354	398945	272929	65667	394435	268419	64715
					1.3000	0.5800	398945	272929	70130	391542	265526	67998
					1.4000	0.6246	398945	272929	74470	388741	262725	71075
					1.5000	0.6692	398945	272929	78690	386025	260009	73962
				Fmsy	**1.435**	**0.640**	**398945**	**272929**	**75960**	**387781**	**261765**	**72106**

5.2.2 STOCK ASSESSMENT OF TURBOT

5.2.2.1 Stock Identification

Different opinions exist regarding the availability of turbot local populations (ecotypes) in the Black Sea. Shlyakhov (2014) considered that turbot in the Black Sea is presented by several local populations, which mix in the adjacent areas. The “Western” population is distributed in the waters of Ukraine, Romania and possibly in Bulgaria, where it mixes partially with the local population and the “North-Eastern” population is distributed in the waters of the Russian Federation, Ukraine and partially in Georgia (Shlyakhov, 2014). The core of the Western stock is situated in the Ukrainian waters in the north-western Black Sea, and the North-Eastern stock, in Russian waters. According to (Shlyakhov, 2014), the ratio of W-stock to NE stock biomasses is about 38:1 and the share of the W-stock in the Ukrainian annual catch varies from 80 % to 95 %.

Analysis of the sequence variation of the mitochondrial control region (CR) of turbot specimens collected from different locations along the Bulgarian and North Romanian Black Sea coasts did not provide clear indications on the existence of phylogeographic differentiation among the studied turbot populations inhabiting the Western Black Sea (Atanassov et al., 2011). So far, there is no conclusive evidence for the existence of multiple stocks of turbot in the Black Sea and a clear definition of stock boundaries is missing (Sampson et al. 2013; GFCM 2014). Thus, the present assessment is based on the analysis of the best available information, provided by Black Sea coastal countries and assuming the turbot stock represents a single unit in the entire Black Sea.

5.2.2.2 Growth

Turbot is a slow growing, long lived species (Stoyanov et al. 1963). The maximum reported longevity is 10 – 12 for the Bulgarian, Romanian and Turkish coasts (Stoyanov et al. 1963, Karapetkova, Zivkov 2006, Zengin et al. 2006) and 17 - 23 years for the Russian and Ukrainian coasts (Popova 1954, Vassileva 2007, Shyakhov 2014). Turbot reach maximum total length of 85 - 87 cm and weight of 12 - 15 kg (Stoyanov et al., 1963, Karapetkova and Zivkov 2006, Vassileva, 2007).

The parameters reported by countries are considered appropriate for the description of an average growth performance of the species in GSA 29 (Tab. 5.2.2.2.1).

Table 5.2.2.2.1. Turbot in GSA 29. Growth parameters by countries and periods.

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	A	B
ROM	29	2003-2005	TUR	C	81.0	0.15	-1.37	0.00002	3.010
ROM	29	2006-2008	TUR	C	72.5	0.21	-1.15	0.00806	3.220
ROM	29	2009-2011	TUR	C	86.3	0.19	-2.10	0.03009	2.870
BGR	29	2007-2008	TUR	C	77.8	0.24	0.15	0.00043	2.210
BGR	29	2008-2009	TUR	C	120.4	0.08	-2.81	0.00001	3.130
BGR	29	2008-2009	TUR	F	129.8	0.07	-3.35	0.00001	3.110
BGR	29	2008-2009	TUR	M	67.4	0.25	-1.22	0.00004	2.780
BGR	29	2007-2008	TUR	M	57.6	0.51	0.46	0.00092	1.960
BGR	29	2007-2008	TUR	F	80.3	0.21	-0.14	0.00042	2.220
BGR	29	2006-2007	TUR	M	77.5	0.16	-1.98	0.00002	2.920
BGR	29	2006-2007	TUR	F	124.3	0.08	-2.14	0.00002	2.940
BGR	29	2006-2007	TUR	C	79.3	0.17	-1.56	0.00001	3.170
UKR (NE)	29	2000 - 2006	TUR	C				0.00022	2.480

UKR (NW)	29	2008 - 2009	TUR	C	74.0	0.11	-1.73	0.00144	1.940
TR	29	1990 - 1991	TUR	C	82.6	0.17	-0.93	0.00850	3.180
TR	29	1990 - 1996	TUR	C	96.2	0.12	-0.01	0.01120	3.120
TR	29	1998 - 2000	TUR	C	95.9	0.10	-1.55	0.01060	3.140
BGR-RO	29	2010	TUR	M	73.4	0.19	-1.78	0.00004	2.799
BGR-RO	29	2010	TUR	F	113.6	0.09	-2.49	0.00000	3.795
TR	29	2010	TUR	C	60.6	0.22	0.25	0.12000	3.081
BGR	29	2011	TUR	C	70.0	0.40	1.04	0.00003	2.837
TR(west)	29	2011	TUR	C	96.4	0.11	-1.30	0.01400	3.059
TR(east)	29	2011	TUR	C	101.1	0.11	-1.24	0.01000	3.170
RO	29	2011	TUR	C	86.3	0.24	-1.97	0.06000	2.660
BGR	29	2012	TUR	C	88.4	0.17	-0.34	0.00000	2.860
RO	29	2012	TUR	C	86.3	0.22	-0.49	0.04000	2.840
TR	29	2012	TUR	C	82.4	0.34	-3.73	0.01000	3.090
BG	29	2013	TUR	C	97.2	0.14	-0.61	0.00000	2.580
TR	29	2013	TUR	C	86.0	0.14	-1.15	0.01000	3.070
RO	29	2013	TUR	C	76.8	0.39	-0.48	0.01000	3.150
BG	29	2014	TUR	c	108.6	0.12	-0.25	0.00003	2.853
BG	29	2014	TUR	c	69.5	0.36	-0.48	0.00840	3.180
RO	29	2014	TUR	c	89.4	0.20	-1.11	0.01330	3.051

Differences were observed in the estimated growth parameters of turbot in different countries (Table 5.2.2.2.1) which might be due to different environmental conditions, differences in the age reading methods and the existence of local populations.

5.2.2.3 Maturity

The maturity ogive for 2014 was estimated based on data collected during surveys (DCF, from commercial fisheries, national monitoring programs, etc.) from Bulgaria and Romania, averaged by age groups. No data were available from other countries. The proportions of mature individuals by age groups for the period 1970 – 2014 are given in Table 5.2.2.3.1.

Table 5.2.2.3.1. Common maturity ogive of turbot by ages and years.

Year/Age	1	2	3	4	5	6	7	8	9	10+
1970-2006	0	0	0.75	1	1	1	1	1	1	1
2007	0	0	0.38	0.61	1	1	1	1	1	1
2008	0	0	0.51	0.76	1	1	1	1	1	1
2009	0	0	0.41	0.67	1	1	1	1	1	1
2010	0	0	0.22	0.83	1	1	1	1	1	1
2011	0	0.06	0.20	0.86	1	1	1	1	1	1
2012	0	0.13	0.52	0.92	1	1	1	1	1	1
2013	0	0.04	0.69	0.93	1	1	1	1	1	1
2014	0	0.70	0.90	0.99	1	1	1	1	1	1

5.2.2.4 Natural mortality

No new information was provided regarding the natural mortality of turbot and thus the same values as estimated in 2014 were used.

5.2.2.5 Fisheries

5.2.2.5.1 General description of the fisheries

The main fishing grounds in the Black Sea cover the shelf area up to 140 m depth along the entire Black Sea coast. In the Black Sea, the shelf in the South Eastern part is very narrow and anoxic conditions exist under the 140 m depth, which limits the distribution of the demersal fishes. The Black Sea turbot has been fished by all coastal states, using both stationary and mobile fishing gears (gillnets and bottom trawls). The species is also caught as a by-catch of otter trawls, long lines and purse seiners fishery. Existence of IUU fisheries on turbot in the Black Sea area is widely aknowledged as a common phenomenon.

5.2.2.5.2 Management regulations applicable in 2015

The management measures concerning the turbot stock in Black Sea already in force are given by country. In Black Sea EU waters, turbot fishery has being managed through the annual establishment of fishing opportunities (EU quotas) since 2008, by the adoption of Council Regulations. During the last five years, the EU turbot quota has been fixed at 86.4 t and allocated to Bulgaria and Romania (50 % each). The same Council Regulations sets up every year the prohibition of fishing activities during spawning period for turbot. The ban has been in force from 15 April to 15 June in European Community waters of the Black Sea. The same period of prohibition is fixed by Turkish National Legislation.

<u>Bulgaria</u>

In Bulgaria, effort restrictions include constant fleet capacity based on the EU Reg 31/12/2002 and gear restrictions - prohibition of usage of bottom trawls and dredges. Gillnets mesh size in Black Sea EU waters is fixed to 400 mm stretched and the minimum landing size is set to 45 cm (TL). Participatory restrictions include individual annual quotas by vessels and logbooks for turbot fishery.

<u>Romania</u>

Fishing effort on turbot is regulated by special authorization and licenses required for targeting turbot. Usage of bottom trawls and dredges are prohibited and the gillnets mesh size is set to 400 mm stretched. Monofilament gillnets are forbidden. Minimum landing size for turbot is 45 cm (TL).

<u>Turkey</u>

In Turkey, turbot fisheries have been traditionally conducted by bottom set gill nets with minimum mesh size of 320-400 mm and by bottom trawls - with minimum mesh size 40 mm. Temporal restrictions ban bottom trawling for turbot between 15 April and 15 September. Turbot fishery by gillnet is forbidden during the period 15 April – 15 June. Minimum landing size for turbot is 45 cm (TL).

<u>Ukraine</u>

Temporal restrictions in Ukraine include 15 – 30 days fishing prohibition during the spawning period in the coastal 12-mile zone for harvesting of fish with trawls, net and long-lines. Fishery ban on the use of gillnets for turbot during the period from 1 November to 31 January, 1 -31 May - for the EEZ and 15 days for the territorial waters within the month of May. Turbot catches are regulated by establishment of annual TACs. By-catch of juveniles during the non-target fisheries allows quantities less than 2% of total catch weight and during the target fisheries with nets (with mesh size 360 mm) – less than 5% in numbers. Turbot by-catch in trawl catches of sprat should be less than 4 individuals per one ton of the catch. Effort restrictions include limitations of number of gears as a total as well as the minimum number of gears per vessel. In Ukraine, the usage of bottom trawls is prohibited and the bottom (turbot) gillnets for turbot should be with mesh size of 360 - 400 mm. Minimum landing size for turbot is 35 cm (SL).

Georgia

Temporal restrictions in Georgia include fishing closure between 1 May and 1 July. Turbot fishery by trawlers and seiners is regulated through TACs. Minimum mesh size for gillnets is 120 mm from knot to knot and the minimum landing size is 35 cm (SL).

No information was available for Russia.

Recently, new recommendations at GFCM level were introduced, valid for Bulgaria, Romania and Turkey. Non-contracting party status was granted to Georgia and Ukraine in light of their increasing involvement in GFCM activities in the Black Sea (GFCM, 2015). At GFCM level, trawling within 3 nautical miles off the coast is prohibited, provided that the 50 meters isobath is not reached, or within the 50 meters isobath where that depth is reached at a shorter distance from the coast. Resolution GFCM/33/2009/1 calling a reduction of a minimum of 10% of bottom trawling fishing effort to be applied in all GFCM areas, unless proven unnecessary by sound scientific advice. Recommendation GFCM/37/2012/2 on the establishment of a set of minimum standards for bottom-set gillnet fisheries for turbot and conservation of cetaceans in the Black Sea set the following:

- Turbot in the Black Sea (GSA29) should be fished exclusively by using bottom-set gillnets.
- Minimum mesh size for the bottom set gillnets is 40 cm stretched.
- Maximum monofilament or twine diameter of 0.5 mm.
- Minimum 40 mm square mesh or a diamond mesh size of at least 50 mm in the codend of demersal trawl nets.
- Minimum landing size is 45 cm of total length.

Recommendation GFCM/39/2015/3 established a set of measures to prevent, deter and eliminate illegal, unreported and unregulated fishing in turbot fisheries in the Black Sea.

5.2.2.5.3 Catches (by fleet if posible)

Turbot catches include landings, discards and the by-catch in fisheries targeting other pelagic and demersal fishes. Turbot is by-caught in otter trawls, long lines and beam trawl fishery due to low selectivity of the gears. The by-catch of other non-target species (*R. clavata, S. acanthias, Acipenser* spp., cetaceans) in turbot fishing gear could be significant. No new data were provided about by-catch rates.

5.2.2.5.4 Landings

Landings data for Bulgaria and Romania were reported to the STECF EWG 15 12 through the EU Data collection program (Tab. 5.2.2.5.4.1) and for Turkey, Ukraine and Russia according to the official statistics of each country. The data set of landings by countries was compiled for the period 1989 – 2014 with the estimates of IUU landings added. (Tab. 5.2.2.5.4.2).

Table 5.2.2.5.4.1. Turbot in GSA 29. Official landings in Black Sea EU waters by fleet type.

Country	Year	Fleet	Gear	Mesh size range	Fishery	Landings
BUL	2014	VL1824	GNS	400DXX	MDPSP	6.3
BUL	2014	VL0612	GNS	400DXX	MDPSP	13.4
BUL	2014	VL1218	GNS	400DXX	MDPSP	16.3
BUL	2014	VL0006	GNS	400DXX	MDPSP	0.7
BUL	2014	VL2440	GNS	400DXX	MDPSP	2.7
ROM	2014	VL2440	OTM	14D16	MDPSP	0.7
ROM	2014	VL1218	GNS	400DXX	DEMF	8.3
ROM	2014	VL0612	GNS	400DXX	DEMF	25.1
ROM	2014	VL0612	FPN	14D16	MDPSP	0.1
ROM	2014	VL0006	GNS	400DXX	DEMF	0.2
ROM	2014	VL1218	OTM	14D16	MDPSP	1.8
ROM	2014	VL2440	GNS	400DXX	DEMF	7.0

Table 5.2.2.5.4.2. Turbot in GSA 29. Official landings and landings plus the IUU estimates during the period 1989 – 2014.

Year	Bulgaria	Georgia	Romania	Russian Federation (incl. Crimea)	Turkey	Ukraine	Total	Total landings incl. IUU
1989	1	8	0	0	1449	2	1460	
1990	0	1	0	0	1383	9	1393	
1991	0	0	2	0	915	18	935	
1992	0	0	1	1	418	19	439	
1993	0	0	6	2	1585	10	1603	
1994	0	0	6	5	2114	19	2144	
1995	60	0	4	19	2850	10	2943	
1996	62	0	6	17	1924	39	2048	
1997	60	0	1	11	911	42	1025	
1998	64	0	0	14	1468	42	1588	
1999	54	5	2	15	1804	73	1953	
2000	55	9	2	4	2639	80	2789	
2001	57	11	13	24	2323	129	2557	
2002	136	11	17	15	335	104	618	1567
2003	41	1	24	15	219	124	424	1122
2004	16	7	42	2	234	133	434	1142
2005	13	7	37	8	548	129	741	1400
2006	15	0	35	8	747	162	967	1751
2007	67	0	48	6	699	216	1035	2259
2008	55	0	47	5	458	251	816	2122
2009	52	0	49	24	342	263	731	2078
2010	46	0	48	25	295	207	622	1738
2011	38	0	43	24	145	236	486	1659
2012	36	0	43	26	172	241	518	1704
2013	40	0	43	30	194	193	500	1522
2014	39	0	43	111	180	102	475	1159

5.2.2.5.5 Discards

No data for turbot discards have been reported by countries to STECF EWG 15 12 Black Sea assessments. However, the discards for the gillnets fishery are considered to be negligible for turbot in the Black Sea due to the selectivity of the gear.

5.2.2.5.6 Fishing effort (by fleet if possible)

Total fishing effort data for Bulgaria and Romania (Table 5.2.2.5.6.1) were reported to EWG 14 14 through the EU Data collection program.

Table 5.2.2.5.6.1 DCF total fishing effort data (kW days at sea) by gear of Bulgaria and Romania in 2014.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT days at sea	No. vessels
BUL	2014	VL0006	LLD		DEMF	13	1	1
BUL	2014	VL0006	SB	00D14	MDPSP	787	225	30
BUL	2014	VL0006	GNS	400DXX	MDPSP	22134	1967	331
BUL	2014	VL0006	FPO	00D14	SPF	250	70	10
BUL	2014	VL0006	LLS		DEMF	975	42	4
BUL	2014	VL0006	LHP		DEMF	2756	211	70
BUL	2014	VL0612	GNS	400DXX	MDPSP	141364	11277	479
BUL	2014	VL0612	FPO	00D14	SPF	21619	2115	42
BUL	2014	VL0612	OTM	00D14	MDPSP	22462	2130	13
BUL	2014	VL0612	LLS		DEMF	1650	99	5
BUL	2014	VL0612	SB	00D14	MDPSP	394	63	10
BUL	2014	VL0612	LLD		DEMF	5766	514	9
BUL	2014	VL0612	LHP		DEMF	17001	1424	128
BUL	2014	VL1218	LLD		DEMF	19432	2553	15
BUL	2014	VL1218	OTM	00D14	MDPSP	197765	23146	30
BUL	2014	VL1218	LHP		DEMF	250	12	1
BUL	2014	VL1218	LLS		DEMF	1314	224	4
BUL	2014	VL1218	GNS	400DXX	MDPSP	142989	18061	47
BUL	2014	VL1824	LLS		DEMF	2677	326	3
BUL	2014	VL1824	LLD		DEMF	3353	502	2
BUL	2014	VL1824	GNS	400DXX	MDPSP	82070	15148	14
BUL	2014	VL1824	LHP		DEMF	772	119	1
BUL	2014	VL1824	OTM	00D14	MDPSP	147802	38423	14
BUL	2014	VL2440	LLD		DEMF	662	352	1
BUL	2014	VL2440	GNS	400DXX	MDPSP	508612	213445	21
BUL	2014	VL2440	OTM	00D14	MDPSP	446276	204906	12
ROM	2014	VL0006	GNS	20D40	SPF	2424	63	4
ROM	2014	VL0006	GNS	400DXX	DEMF	539	14	4
ROM	2014	VL0006	FPN	14D16	MDPSP	184	111	2
ROM	2014	VL0006	LHP		SPF	3	1	1
ROM	2014	VL0006			DEMSP	1284	107	3
ROM	2014	VL0006	GNS	100D400	DEMF	0	2	1
ROM	2014	VL0612	GNS	20D40	SPF	93639	2492	19
ROM	2014	VL0612	OTM	14D16	MDPSP	176	12	1

ROM	2014	VL0612	SB	14D16	SPF	0	1	1
ROM	2014	VL0612	LHP		SPF	0	2	1
ROM	2014	VL0612	FPN	14D16	MDPSP	151561	38512	20
ROM	2014	VL0612	GNS	100D400	DEMF	48	4	1
ROM	2014	VL0612	FPO	14D16	MDPSP	4	1	1
ROM	2014	VL0612	LLS	-1	DEMF	88	6	1
ROM	2014	VL0612	GNS	400DXX	DEMF	185427	7952	38
ROM	2014	VL0612	TBB	50D100	DEMSP	396849	27151	25
ROM	2014	VL1218	LLS		DEMF	358	70	1
ROM	2014	VL1218	GNS	20D40	SPF	2148	420	1
ROM	2014	VL1218	GNS	400DXX	DEMF	62525	11152	7
ROM	2014	VL1218	TBB	50D100	DEMSP	580315	85396	10
ROM	2014	VL1218	GNS	100D400	DEMF	345	115	1
ROM	2014	VL1218	OTM	14D16	SPF	40410	5940	4
ROM	2014	VL2440	OTM	14D16	SPF	71142	15360	2
ROM	2014	VL2440	GNS	400DXX	DEMF	11116	2400	2
ROM	2014	VL2440	TBB	50D100	DEMSP	114495	24720	2

The number of fishing vessels, involved on turbot fisheries operating in Turkish Black Sea area are given in Table 5.2.2.5.6.2.

Table 5.2.2.5.6.2. Number of Turkish fishing vessels, operating on turbot fisheries in the Black Sea area.

Year	Vessels	Year	Vessels
1987	102	2001	286
1988	89	2002	300
1989	96	2003	133
1990	223	2004	141
1991	94	2005	212
1992	273	2006	231
1993	286	2007	206
1994	204	2008	263
1995	166	2009	237
1996	298	2010	225
1997	266	2011	298
1998	264	2012	362
1999	338	2013	486
2000	340	2014	345

No data were available for fishing effort from Ukraine, Russia and Georgia.

5.2.2.6 Scientific surveys

Three demersal trawl surveys in Community waters (Bulgaria and Romania) were conducted under the national Data collection programs of Bulgaria and Romania in 2014. Surveys were aiming to assess the turbot abundance and biomass indices during the spring and autumn seasons in 2014.

5.2.2.6.1 Survey #1 Romanian bottom trawl survey

5.2.2.6.1.1 Methods

Standard methodology for stratified random sampling and swept area method were applied. The method is based on bottom trawling across the seafloor (area swept) and is widely used as a direct method for demersal fish stock assessment when only an index of abundance is required. The total number of hauls by depth strata in 2014, are given on Table 5.2.2.6.1.1.1.

Table 5.2.2.6.1.1.1. Number of hauls per depth stratum of the Romanian survey conducted in 2014.

Period	Stratum	Number of hauls
May - June	0 - 35 m	10
	35 - 50 m	14
	50 - 75 m	17
	75 - 100 m	0
	TOTAL	41
Nevember	0 - 35 m	11
	35 - 50 m	15
	50 - 75 m	14
	75 - 100 m	0
	TOTAL	40
TOTAL HAULS		81

The bottoms surveys in the Romanian waters were executed during the 2nd and 4th quarter of 2014. The employed gear was bottom trawl 22/27-34 with horizontal opening of 13m. The average trawling speed was 2.4 knots during the spring survey and 2.5 knots during the autumn with the standard haul duration of 60 minutes.

5.2.2.6.1.2 Geographical distribution

In spring season, the survey covered almost the entire Romanian shelf area between St. Gheorghe and Vama Veche at depths between 13.8 m and 80 m with a total surveyed area of 2600 Mm^2. Low average turbot catches (0.00 - 0.395 t/Nm^2) were observed. The lowest values were recorded in the shallower areas between Cap Midia – Cap Tuzla (depth 0 -30 m / 0.000 – 0.136 t/Nm^2 and depths 30 - 50 m / 0.00 – 0.395 t/Nm^2) and the highest – in the Constanta – Sf. Gheorghe area (depth 30 - 75 m / 0.0 - 0.286 t/Nm^2) (Fig. 5.2.2.6.1.2.1).

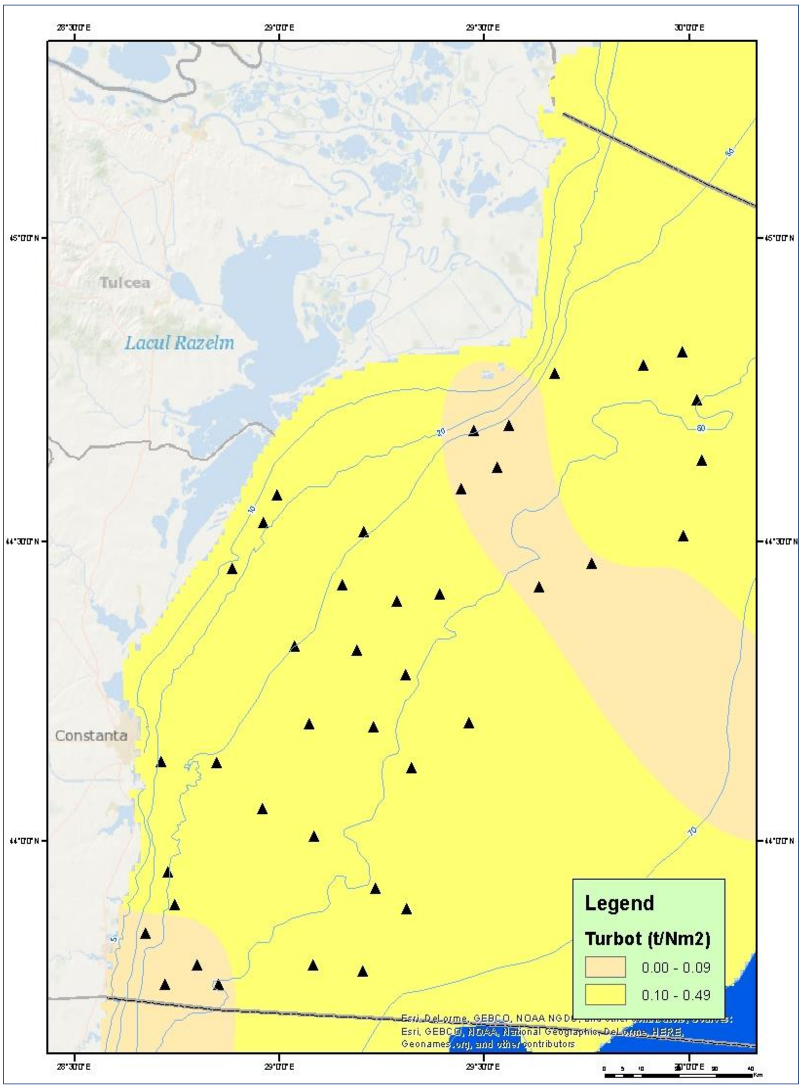


Fig. 5.2.2.6.1.2.1. Turbot in GSA 29. Distribution of biomass indices in spring season, as estimated by the Romanian survey in 2014.

Autumn survey covered the Romanian shelf area enclosed between St. Gheorghe and Vama Veche at depths between 20 m and 65 m with total coverage of 2 650 Nm^2. The observed distribution of turbot agglomerations was different. The average values of turbot catches ranged between 0.040 and 0.067 t/Nm^2 (Fig. 5.2.2.6.1.2.2).

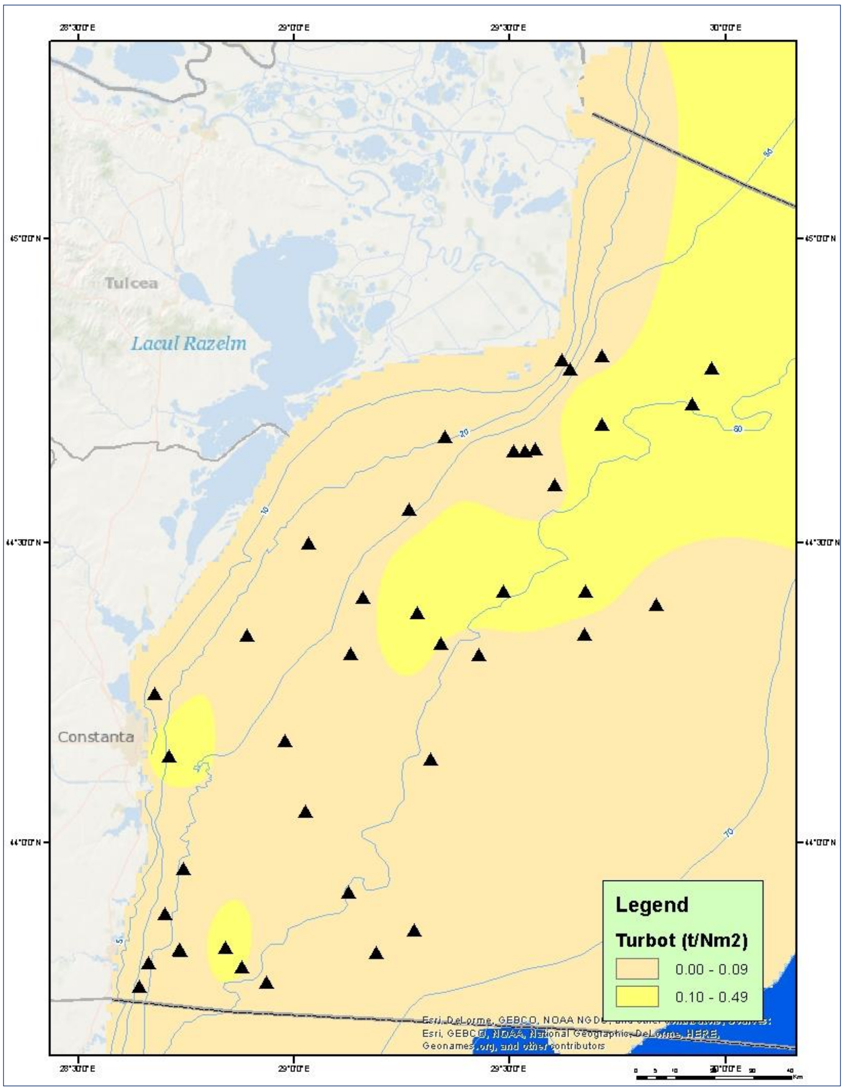


Fig. 5.2.2.6.1.2.2. Turbot in GSA 29. Distribution of biomass indices in autumn season, as estimated by the Romanian survey 2014.

5.2.2.6.1.3 Trends in abundance and biomass

Estimated biomass of turbot during spring survey over the surveyed area was 152 tonnes and the total estimated biomass for the Romanian shelf, up to a distance of 50 nm, was about 292 tonnes (Tab. 5.2.2.6.1.3.1).

Table. 5.2.2.6.1.3.1. Turbot in GSA 29. Estimates of abundance and biomass in the period May - June 2014, demersal trawl survey, Romanian area.

Depth range (m)	0–30 m	30–50 m	50-70 m	Total
Investigated area (Nm^2)	625	1150	825	2600
Variation of the catches (t/ Nm^2)	0-0.136	0-0.395	0-0.303	0-0.395
Average catch (t/ Nm^2)	0.027	0.081	0.040	0.058
Biomass of the fishing (t)	14.4	93.7	33.6	151.8
Biomass extrapolated the Romanian shelf (t)				291.9

Estimated biomass of turbot during the autumn survey in the investigated area was about 134 tonnes and the total estimated biomass for the Romanian shelf, up to a distance of 50 nm, was about 252 tonnes (Tab. 5.2.2.6.1.3.2).

Table 5.2.2.6.1.3.2. Turbot in GSA 29. Estimates of abundance and biomass in November 2014, demersal trawl survey, Romanian area.

Depth range (m)	0 – 30 m	30 – 50 m	50-70 m	Total
Investigated area (Nm^2)	625	1150	875	2650
Variation of the catches (t/ Nm^2)	0-0.111	0-0.380	0-0.293	0-0.380
Average catch (t/ Nm^2)	0.046	0.040	0.067	0.050
Biomass of the fishing agglomerations (t)	29.3	46.9	58.7	133.5
Biomass extrapolated the Romanian shelf (t)				252.0

5.2.2.6.1.4 Trends in abundance by length or age

The length of turbot individuals ranged between 25-76 cm and 250g – 6.96 kg. The dominant classes are those of 40- 58 cm / 900 g– 2.88 kg. Females 31.58 % / 6 individual, males (47.37 % / 9 individual), and remaining 21.05 % being juvenile / 4 individuals. The average body length was 47.97 cm and the average weight of 1668 g.

The lengths of turbot individuals varied between 19.0 - 67.0 cm and 200 – 5 150 g. The dominant classes are those of 28.0 - 49.0 cm / 350 – 1,967.5 g. The ratio per sexes indicates a clear dominance of juvenile 62.96% / 17 individual and males (29.63% / 8 individual) Females only 7.41 % / 2 individual. The average body length was 40.83 cm and the average mass of 1 690 g.

Age composition of turbot catches indicates the presence of individuals of age between 2 and 5 years. Most of the caught individuals are 2 years old (40.0% of all specimens analyzed) and 3 years (41 %), followed closely by those of 4 years (15 %) and 5 years (4.0 %).

5.2.2.6.2 Survey #2 Bulgarian bottom trawl survey

5.2.2.6.2.1 Methods

A demersal trawl survey was carried out in Bulgarian shelf area in November 2014. The survey applied the standard methodology for stratified random sampling and swept area method. The method is based on the bottom trawling across the seafloor (area swept) and is widely used as a direct method for demersal fish stock assessment when only an index of abundance is required. The total number of hauls carried out in 2014 was 37. The average trawling speed was 2.2 knots with a standard haul duration of 60 minutes.

5.2.2.6.2.2 Geographical distribution

No information were provided.

5.2.2.6.2.3 Trends in abundance and biomass

Estimated abundance and biomass in 2014 were reported through the DCF Data call and the data are given in Tab. 5.2.2.6.2.3.1.

Table. 5.2.2.6.2.3.1. Turbot in GSA 29. Estimates of abundance and biomass in November 2014, Bulgarian Black Sea.

Age	Abundance (10^3)	Biomass (t)

2	230	118
3	401	528
4	98	280
5	50	22
6	61	32
Total	840	980

Analysis of the trend in the survey indices during the period 2006 – 2014 indicated a decreasing trend in turbot biomass since 2008. Howvever, the estimated biomass in 2014 is 5 times higher compared to 2012 – Fig. 5.2.2.6.2.3.1.

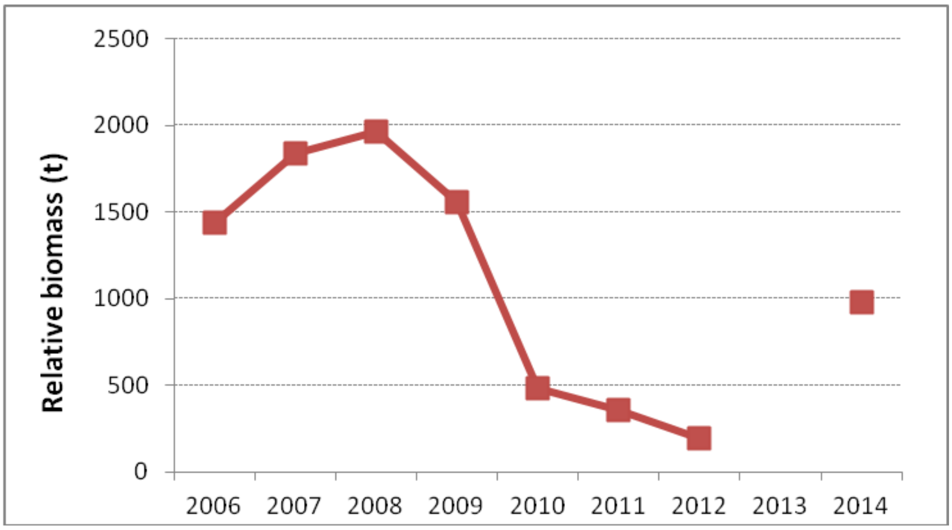


Fig. 5.2.2.6.2.3.1. Turbot in GSA 29. Biomass indices derived from the national surveys in the Bulgaria area during the period 2006 – 2014.

5.2.2.6.2.4 Trends in abundance by length or age

Size structure of catches during the survey are presented in Fig. 5.2.2.6.2.4.1.

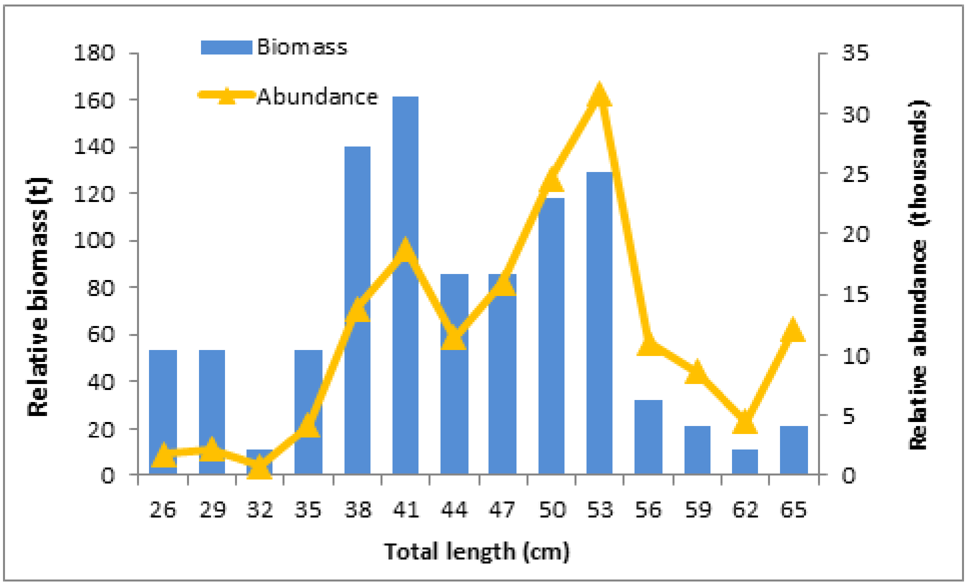


Fig. 5.2.2.6.2.4.1. Turbot in GSA 29. Estimated biomass and abundance indices by length groups during the demersal survey in the Bulgarian Black Sea area reported through data call in 2015 (November, 2014).

5.2.2.7 Stock Assessment

5.2.2.7.1 Methods

Turbot stock in the Black Sea was assessed by state-space assessment model (SAM) (Nielsen et al., 2012) in FLR environment.

5.2.2.7.2 Input data

The data set for the period 1950-2014 was compiled using the historical data sources (Ivanov, Beverton, 1985; Ivanov, Karapetkova, 1979; Prodanov et. al, 1997, Daskalov et.al, 2012; Sampson et.al, 2014) and new data for 2014. Available data of total landings, catch at ages, weights and maturity at age are considered appropriate for assessment of the stock using the state-space assessment model (SAM) (Nielsen et al., 2012) in FLR environment. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package "FLSAM". The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES and it has been used for the assessment of Black Sea turbot since 2012. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. All assessments are performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore). Five tuning series (4 surveys and 1 commercial CPUE series were compiled from the previous assessments (Sampson et al., 2014) and recent data. In 2014, 3 surveys were updated – Romanian and Bulgarian research surveys and the Turkish CPUE survey. Input data types and details are given in Tab. 5.2.2.7.2.1.

Table 5.2.2.7.2.1. Turbot in GSA 29. Input data, used in the SAM assessment.

Name	Type	Year range	Age range	Data modifications	Variable from year to year
$LA_{(1)}$	Catch in tonnes	1950 - 2014	2 - 10+	See note 1	Yes
$CN_{(2)}$	Catch-at-age in numbers	1950 - 2014	2 - 10+	See note 2	Yes
$CW_{(3)}$	Weight-at-age in the commercial catch	1950 - 2014	2 - 10+	See note 3	Yes
$SW_{(3)}$	Weight-at-age of the spawning stock	1950 - 2014	2 - 10+	See note 3	Yes
$NM_{(4)}$	Natural mortality	1950 - 2014	2 - 10+	See note 4	No
PF	Proportion of fishing mortality before spawning	1950 - 2014	2 - 10+	See note 7	No
$MO_{(5)}$	Proportion mature-at-age	1950 - 2014	2 - 10+	See note 5	No
PM	Proportion of natural mortality before spawning	1950 - 2014	2 - 10+	See note 7	No
$TUN_{(6)}$	West Ukrainian survey	1989 - 2007	4 – 10+	No	No
	East Ukrainian survey	1989 - 2006	2 – 10+	No	No

	Romanian survey	2003 - 2014	4 - 9	Yes	Yes
	Bulgarian survey	2006 - 2014	2 - 7	Yes	Yes
	Turkish commercial CPUE	1987 - 2013	2 - 10+	Yes	Yes

(1) Assessment and qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot were made following the approach in Sampson et al. (2014).
(2) Catch-at-age data for 2014 is derived from the raised national landings statistics by countries (Georgia is not included) and added to the historic catch at age data set compiled during the previous assessments. The catch-at-age data was corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards but they do take into account the IUU catches during the period 2002 - 2014. Combined Bulgarian – Romanian catch at age composition was applied to raise the Ukrainian and Russian landings due to lack of data.
(3) The mean weights at ages in the stock during the period 1989-2014 were assumed equal to the catch weights at age in the landings due to lack of data. The averaged weights-at-age during the period 1989 – 1993 were used to estimate weight at age in 1950 – 1988. Due to lack of 10+ age group in the landings in 2014, the average weight of 10+ group in 2014 was estimated as average over the last 10 years.
(4) A vector of natural mortality (M) by age groups was estimated by ProdBIOM ver.2009 (Abella et.al, 1997, 1998) using different sets of parameters in VBGF (Table 6.2.1.3.1) estimated for the historical and the modern part of the time series.
(5) Maturity ogive was calculated as the average for the period 2007 – 2009 due to good consistency for these years and applied over the whole period.
(6) Bulgarian survey data, reported through DCF was modified due to inconsistency in the methodology used during the previous assessments and the errorroneus weights at age data for the ages 5 and 6. The reported numbers at age classes were re-estimated using the ALK from the last survey in Bulgarian area during 2014.
(7) Changes to 0.33 so that SSB is estimated at the 1st of May.

Estimation of IUU turbot fisheries in the Black Sea (ToR 9)

Some new documents were published recently, dealing with IUU (Illegal, Unregulated and Unreported) fisheries on turbot in the Black Sea. Review of the documents revealed that most of them (Ulman, 2013; Keskin et. al, 2015) used the methodology, approaches and assumptions, published by Daskalov and Ratz in 2011 (STECF, 2011) addressing likely historic IUU catches. These studies were not meant to propose new methodologies for the future assessments of IUU rates, although their historic perspective can shed light on most likely past IUU patterns. One of the sources (EU, 2009), dealing with the Bulgarian turbot catches, stated that “The official quota for turbot is currently 50 tonnes (for 2009). The reality (based on personal estimations of local collaborators) is that the actual harvest is about 300 tonnes”, without any justification and description on the estimation methods. Keskin et al., (2015), assumed that the unreported catches of turbot in Bulgaria during 1996 – 2010 were estimated at 250 t per year, following the approach developed by STECF (2011). EFCA (2014) provides information about the execution of 14 missions in the Bulgarian and Romanian Black Sea waters for the control of the turbot fisheries. Unfortunately, the inspection results were not available to EWG 15-12. Moreover, no information was available about the rates of the IUU fisheries in Russian and Georgian waters. Thus EWG 15-12 concludes that currently existing and accessible literature sources do not enable the formulation of a new scientific based approach for the calculation of the IUU rates by country and therefore the same approach for estimating IUU catches of turbot in the Black Sea used in 2014 by EWG 14-14 was used also in 2015 by EWG 15-12, which estimates the IUU by rising the cumulative landings of Ukraine, Romania and Bulgaria by a factor of 4.7 and adds them to the official landings of the rest of the countries.

During STECF EWG 11 16, the estimate of IUU catches of turbot was based on the fact that officially reported landings (mostly by Turkey) dropped suddenly in 2002. The STECF EWG Black Sea 11 16 considered that Turkish catch until 2001 (between 1000 and 2000 t) has been actually taken illegally from the north-western part of the Black Sea, transported and sold in the Turkish market and finally reported as Turkish catch. After 2001, Turkish turbot fishery had to rely only on the fishing grounds along the narrow southern Black Sea shelf (Turkish waters) and Turkish landings dropped to about 100-300 t on average, leading to a substantial drop in the total reported landings. On the other hand, STECF EWG Black Sea 11 16 had qualitative information that IUU fishing in Bulgarian, Romanian, and Ukrainian waters is a common practice and that unreported catches may exceed the officially reported catches by several orders of magnitude. Thus, the STECF EWG 11 16 made the assumption that what has been caught before 2001 by Turkish fishermen in the Bulgarian, Romanian, and Ukrainian waters is now caught but not reported by the local fishermen. The rate of IUU to be used in the stock assessment was estimated as the proportion between Turkish catch in 1993-2001 and 2009-2010, which was then used to raise the officially reported catches. The estimated total catch was about 2.44 times higher than the reported landings on average for 2002-2010. The STECF EWG 11 16 considered this value as a maximum potential value and assumed that actual catch may lay in the region between the estimated catches with IUU and officially reported landings.

Estimates of IUU catches (2002-2013) made during EWG 14-14 (STECF 2014) are based on some specific knowledge of illegal fishing along the north-west and west shelf areas (waters of Ukraine, Romania and Bulgaria). Prior to 2002, Turkish vessels have been known to fish illegally inside the territorial waters of Ukraine, Romania and Bulgaria. Their catch has been landed in Turkey and respectively reported by the Turkish landing statistics. By 2001, authorities in Ukraine, Romania and Bulgaria have severed the control against illegal Turkish fishers. These actions are reflected by a sudden drop in Turkish landings in 2002. Since 2002, most of the illegal fishing in Ukrainian, Romanian and Bulgarian waters is carried out by local fisheries. Some of them are known to disembark their catch into Turkish vessels outside of the territorial waters. These illegal catches by Ukrainian, Romanian and Bulgarian fishers are not included in the respective national official catch statistics. We have assumed that IUU catches in Ukrainian, Romanian and Bulgarian waters after 2001 are of the same approximate size as they have been prior to 2002 (when these were taken by Turkish fishers). The IUU catches in 2002-2013, were estimated by rising the cumulative landings of Ukraine, Romania and Bulgaria by a proportion given by the following expression: (mean Turkish landing in 1993-2001 - mean Turkish landing in 2002-2010) divided by the mean cumulative landings by Ukraine, Romania and Bulgaria in 2002-2010. The estimated proportion equals 4.7, which implies that IUU catches in Ukrainian, Romanian and Bulgarian waters are about 5 times larger than the reported landings.

Data exploration

Prior to the assessment run, an exploration analysis of the data was performed and data was assessed as appropriate for stock assessment purposes. The analyses of tuning series are shown on Fig. 5.2.2.7.2.1. The full set of figures of the exploration data analysis is presented in the Annex 1 (available in electronic form under request to STECF/JRC).

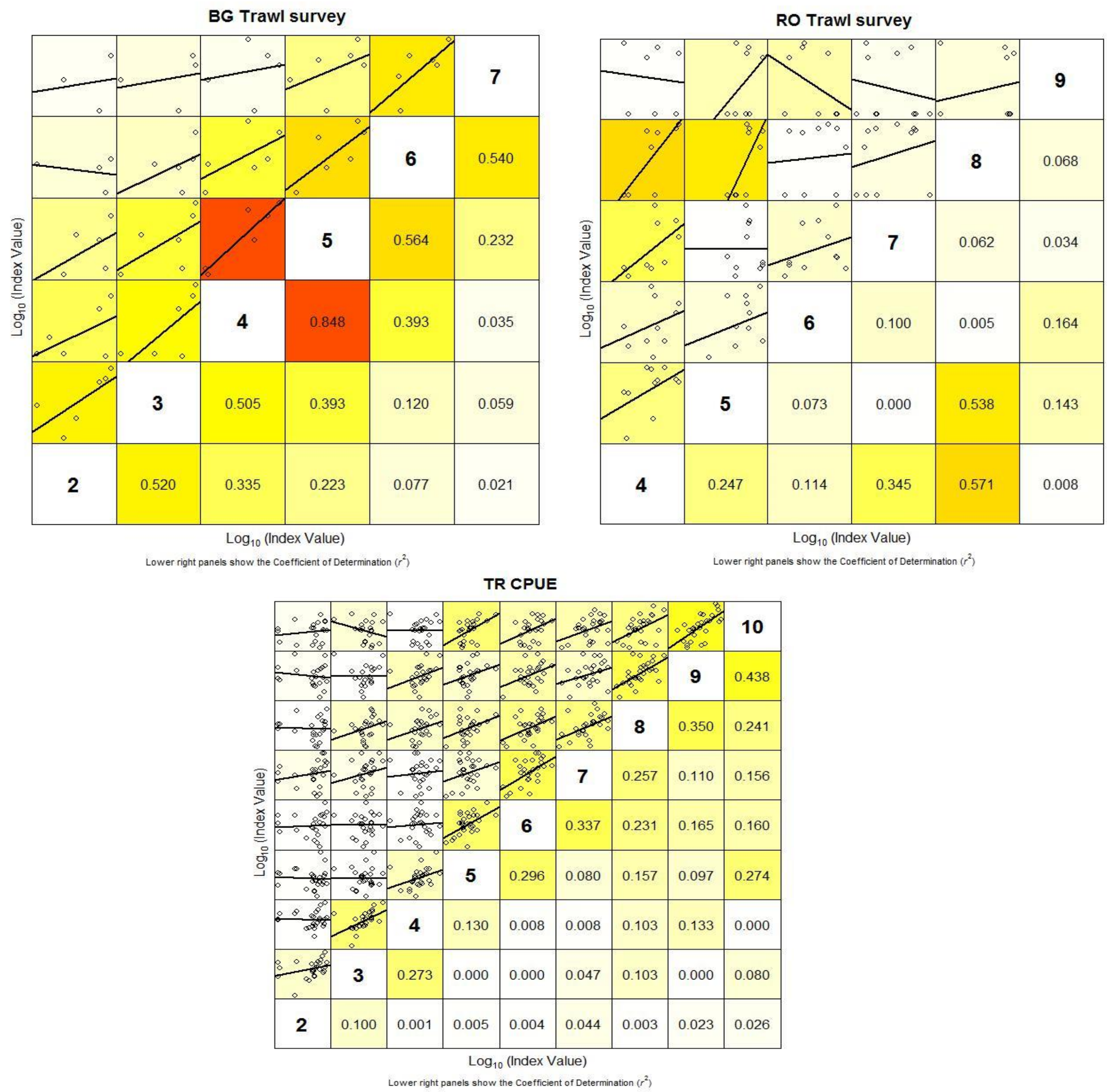


Figure 5.2.2.7.2.1. Turbot in GSA 29. Fitted linear relationships of the cohort trends (i.e. internal consistency) within the three updated tuning series used in the analysis.

SAM input data (Table. 5.2.2.7.2.2 - Table. 5.2.2.7.2.8).

Table 5.2.2.7.2.2. Turbot in GSA 29. Total catches including estimated IUU catches.

Year	Catch	Year	Catch	Year	Catch
1950	3932	1972	3049	1994	2144
1951	4741	1973	3705	1995	2943
1952	5217	1974	1696	1996	2048
1953	4985	1975	1273	1997	1025
1954	4505	1976	1584	1998	1588
1955	3678	1977	2012	1999	1953
1956	3623	1978	2160	2000	2789
1957	3017	1979	5447	2001	2557

1958	4289	1980	2843	2002	1567
1959	4653	1981	3276	2003	1122
1960	2680	1982	4662	2004	1142
1961	3058	1983	5307	2005	1400
1962	2904	1984	2852	2006	1751
1963	3812	1985	527	2007	2259
1964	3666	1986	428	2008	2122
1965	3063	1987	849	2009	2078
1966	3093	1988	1116	2010	1738
1967	2709	1989	1460	2011	1659
1968	2931	1990	1393	2012	1714
1969	3076	1991	935	2013	1522
1970	5273	1992	439	2014	1159
1971	3052	1993	1603		

Table 5.2.2.7.2.3. Turbot in GSA 29. Catch-at-age data (10^3 individuals) including estimated IUU catches.

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**
2	16.4	19.7	23.7	25.1	21.0	18.3	18.0	14.9	21.2	33.4
3	112.9	136.0	164.9	176.9	146.6	128.8	126.9	130.0	259.3	355.7
4	216.7	260.9	321.2	350.0	286.8	254.3	250.6	293.8	383.4	567.8
5	280.4	337.5	420.2	463.3	376.4	336.3	331.4	387.2	486.7	402.0
6	226.2	272.7	302.1	291.3	261.5	214.7	211.5	220.1	309.8	293.2
7	180.1	217.4	224.3	195.5	189.6	145.9	143.7	77.6	138.7	157.7
8	115.1	138.9	139.0	115.3	116.2	86.6	85.3	41.3	57.2	64.6
9	42.0	50.7	52.8	46.8	44.8	34.9	34.3	12.1	18.1	17.7
10+	25.6	30.9	30.9	25.6	25.8	19.2	18.9	6.3	8.5	11.2
age/year	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**
2	27.8	8.9	14.2	43.5	26.0	11.5	21.7	61.7	35.4	30.7
3	138.4	132.0	135.8	235.8	372.0	169.4	132.5	251.3	306.9	334.1
4	231.4	278.9	281.3	235.0	312.1	320.3	206.4	235.7	319.1	362.6
5	205.9	229.9	172.6	262.9	271.2	265.1	267.2	175.8	204.4	262.8
6	183.0	209.7	216.2	290.3	227.8	172.6	236.6	192.7	178.7	187.0
7	109.8	112.4	121.8	181.6	137.0	112.8	132.0	93.4	114.0	98.3
8	58.2	75.7	72.5	94.4	82.6	69.1	70.8	54.0	49.3	40.7
9	13.5	20.1	17.2	15.6	18.1	17.4	13.6	13.3	9.8	8.6
10+	9.4	11.1	5.1	6.8	6.0	9.2	8.1	7.6	4.9	5.4
age/year	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
2	72.6	1.8	1.9	3.4	2.1	0.2	27.7	20.3	22.4	3.6
3	353.9	47.9	72.8	47.2	5.6	11.2	86.7	47.8	64.5	148.2
4	172.0	434.1	49.8	62.2	8.8	30.7	35.1	22.5	50.2	106.0
5	540.6	200.8	202.5	277.0	44.4	145.9	103.8	73.7	195.9	406.4
6	310.8	188.5	209.3	237.5	102.7	99.8	93.1	93.5	134.2	331.8
7	234.8	143.0	175.4	208.9	101.5	63.9	64.8	89.0	99.6	252.5
8	83.9	42.1	72.5	77.7	36.1	19.5	19.1	29.6	30.6	77.9
9	38.2	16.9	28.2	34.3	22.2	7.3	12.7	24.7	19.2	51.7

10+	41.6	15.5	32.0	49.5	40.0	10.0	34.4	64.5	32.1	107.8
age/year	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
2	12.8	18.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11.8
3	75.9	75.3	116.0	158.1	53.8	0.8	0.1	1.2	0.1	33.1
4	41.3	24.2	69.5	98.7	49.5	2.3	0.2	8.3	0.2	41.1
5	162.3	75.8	202.0	375.7	45.8	4.3	4.9	12.6	19.5	59.4
6	193.4	136.4	171.4	212.5	75.4	8.5	5.8	47.7	29.6	68.1
7	147.6	166.7	172.4	192.4	80.8	15.2	11.8	13.9	24.5	34.7
8	49.3	91.0	76.9	77.6	66.2	7.2	0.2	13.6	38.2	16.9
9	25.5	51.1	70.8	70.8	45.8	12.2	2.6	8.6	8.6	15.9
10+	52.0	83.5	157.4	150.3	121.1	27.2	30.8	42.2	55.6	52.6
age/year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
2	55.8	70.7	42.7	436.5	122.8	67.2	38.4	0.0	0.0	0.0
3	68.1	120.8	29.1	366.2	283.9	47.0	40.7	62.3	9.0	69.8
4	104.7	87.6	29.6	150.8	224.6	311.4	130.2	48.8	25.8	114.3
5	94.5	60.4	17.2	63.6	205.0	486.2	168.9	43.6	73.6	76.2
6	37.0	47.0	13.5	25.9	63.0	246.7	210.1	50.4	176.2	184.1
7	29.2	36.4	15.2	14.7	44.7	87.0	97.1	68.8	97.1	146.0
8	20.7	8.4	9.9	14.7	39.5	18.7	42.5	32.3	54.8	25.4
9	12.9	6.1	2.3	11.5	33.7	2.4	10.0	13.6	11.2	12.7
10+	35.6	6.1	2.5	3.2	10.3	2.4	0.0	3.2	0.0	6.3
age/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2	110.2	28.4	84.2	24.4	20.1	51.3	94.1	117.4	129.0	83.9
3	98.4	42.5	163.2	42.6	51.1	154.0	125.8	220.4	139.2	224.0
4	132.5	133.0	123.6	39.7	63.0	157.7	170.4	418.5	312.1	251.3
5	107.8	247.3	145.6	66.5	77.5	109.9	125.8	201.4	197.3	162.7
6	78.7	322.9	101.5	94.0	85.8	52.8	76.8	103.2	132.3	94.0
7	197.6	103.8	72.1	100.8	58.6	43.6	65.8	37.0	69.4	117.2
8	110.9	22.1	6.0	16.9	31.7	28.9	12.6	4.9	24.0	19.2
9	57.0	2.6	1.3	0.9	3.6	2.5	16.3	4.7	4.0	2.8
10+	17.3	7.8	1.6	0.6	0.0	0.8	0.0	0.5	1.5	0.0
age/year	**2010**	**2011**	**2012**	**2013**	**2014**					
2	9.3	294.7	58.2	135.8	230.0					
3	29.9	92.4	94.9	57.5	177.4					
4	103.8	83.1	156.8	207.8	156.9					
5	183.7	107.5	131.3	212.5	101.8					
6	153.7	46.1	46.1	85.4	67.6					
7	86.3	56.1	71.6	37.8	35.2					
8	40.3	64.0	44.0	18.2	7.6					
9	13.5	28.8	21.7	10.6	0.9					
10+	3.3	8.6	5.7	1.1	0.1					

Table 5.2.2.7.2.4. Turbot in GSA 29. Weight-at-age in catch and in the stock (kg).

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
2	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
3	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27

4	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
5	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
6	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
7	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38
8	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
9	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37
10+	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
age/year	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
2	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
3	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
4	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
5	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
6	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
7	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38
8	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
9	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37
10+	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
age/year	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
2	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
3	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
4	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
5	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
6	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
7	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38
8	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
9	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37
10+	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57	10.57
age/year	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	0.87	0.87	0.87	0.87	0.87	0.87	1.00	0.73	0.78	0.95	0.89
3	1.27	1.27	1.27	1.27	1.27	1.27	1.40	1.25	1.15	1.43	1.10
4	1.77	1.77	1.77	1.77	1.77	1.77	1.80	1.78	1.71	2.00	1.54
5	2.24	2.24	2.24	2.24	2.24	2.24	2.20	2.16	2.12	2.65	2.09
6	3.29	3.29	3.29	3.29	3.29	3.29	3.30	3.24	3.03	3.91	2.96
7	4.38	4.38	4.38	4.38	4.38	4.38	4.00	3.90	4.26	5.28	4.44
8	5.67	5.67	5.67	5.67	5.67	5.67	5.30	5.45	5.47	6.30	5.82
9	7.37	7.37	7.37	7.37	7.37	7.37	6.60	6.50	6.60	8.80	8.34
10+	10.57	10.57	10.57	10.57	10.57	10.57	12.12	12.28	9.54	9.54	9.37
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
2	0.76	0.72	1.08	1.08	1.08	1.08	1.08	1.08	0.85	0.79	0.97
3	1.07	0.95	1.00	1.00	1.30	1.30	1.23	1.30	1.28	1.29	1.43
4	1.59	1.57	1.60	1.60	1.70	1.70	1.57	1.70	1.94	1.98	1.95
5	2.08	2.22	2.10	2.10	2.20	2.20	2.22	2.30	2.53	2.40	2.52
6	2.60	2.99	2.80	2.80	3.10	3.10	2.87	3.10	3.20	3.12	3.18
7	4.20	4.42	4.30	4.30	4.30	4.30	3.91	4.10	4.12	4.08	4.24
8	5.90	6.00	6.00	6.00	6.00	6.00	5.23	5.70	5.40	5.40	5.80
9	8.30	8.50	9.50	9.50	7.00	7.00	6.62	9.50	6.60	6.60	6.80

10+	9.47	9.50	10.00	10.50	10.31	9.50	8.32	12.67	10.25	10.00	9.92
age/year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
2	0.84	1.00	0.79	0.57	0.66	0.68	0.60	0.59	0.45	0.34	
3	1.32	1.51	1.40	1.36	1.16	1.19	1.13	1.39	1.23	0.87	
4	1.94	2.11	1.89	1.79	1.75	1.73	1.66	1.96	1.59	1.60	
5	2.55	2.68	2.44	2.42	2.42	2.51	2.36	2.64	2.26	2.36	
6	3.44	3.50	3.12	3.00	3.42	2.62	3.19	3.36	3.09	3.10	
7	4.39	4.47	4.71	4.02	4.20	3.85	3.71	4.27	3.93	3.77	
8	5.78	5.83	6.06	4.69	5.19	5.18	4.96	5.65	4.66	4.44	
9	7.50	7.40	7.50	5.70	6.32	6.00	5.63	6.55	5.95	7.11	
10+	9.84	9.42	9.00	6.64	7.11	7.58	7.00	6.09	7.00	7.75	

Table 5.2.2.7.2.5. Turbot in GSA 29. Natural mortality.

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10+	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
age/year	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10+	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
age/year	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10+	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
age/year	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110

4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10+	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.146	0.146	0.146	0.146	0.146
3	0.110	0.110	0.110	0.110	0.110	0.110	0.139	0.139	0.139	0.139	0.139
4	0.108	0.108	0.108	0.108	0.108	0.108	0.136	0.136	0.136	0.136	0.136
5	0.107	0.107	0.107	0.107	0.107	0.107	0.134	0.134	0.134	0.134	0.134
6	0.106	0.106	0.106	0.106	0.106	0.106	0.133	0.133	0.133	0.133	0.133
7	0.106	0.106	0.106	0.106	0.106	0.106	0.132	0.132	0.132	0.132	0.132
8	0.105	0.105	0.105	0.105	0.105	0.105	0.131	0.131	0.131	0.131	0.131
9	0.105	0.105	0.105	0.105	0.105	0.105	0.130	0.130	0.130	0.130	0.130
10+	0.105	0.105	0.105	0.105	0.105	0.105	0.130	0.130	0.130	0.130	0.130
age/year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
2	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	
3	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	
4	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	
5	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	
6	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	
7	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	
8	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	
9	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	
10+	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	

Table 5.2.2.7.2.6. Turbot in GSA 29. Proportion of mature fish.

age/year	1950	1951	1952	1953	1954	1955	1956	1957
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**1958**	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1

8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	1990	1991	1992	1993	1994	1995	1996	1997
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2	0	0	0	0	0	0	0	0

3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	0	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10+	1	1	1	1	1	1	1	1
age/year	**2014**							
2	0							
3	0.43							
4	0.68							
5	1							
6	1							
7	1							
8	1							
9	1							
10+	1							

Fraction of the harvest before spawning and the fraction of natural mortality before spawning were set to 0.33, which implies the SSB to be estimated at 1st of May, which corresponds to the assumed peak of spawning of turbot in the Black Sea.

Table 5.2.2.7.2.7. Turbot in GSA 29. Tuning series.

RO Trawl	survey	-	Configu ration								
BLACK	SEA	TURBOT	Total	2014	COMBSE X	TUNING	DATA(effort	nos at age.	Import ed	from	VPA file.
min	max	plusgroup	minyear	maxyear	startf	endf					
4	9	9	2003	2014	0.45	0.55					
Index	type	:	number								
RO	Trawl	survey	-	Index	Values						
Units	:	NA									
age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
4	71.57	63.16	113.18	145.08	244.96	228.11	136.44	126.53	173.48	129.46	68.30
5	64.24	77.36	79.23	145.09	105.58	101.16	107.2	98.98	138.42	145.06	42.03
6	70.08	68.31	24.52	36.69	26.94	35.23	58.24	47.97	68.15	83.71	27.15

7	39.42	16.75	16.98	11.02	13.48	14.03	35.74	26.23	37.8	53.55	13.14
8	0.01	16.43	21.28	0.01	0.01	0.01	15.23	12.28	32.75	20.07	0.01
9	0.01	0.01	0.01	0.01	0.01	0.01	10.12	2.53	6.76	3.77	0.01
age/year	**2014**										
4	40.005										
5	26.275										
6	19.416										
7	15.03										
8	2.507										
9	0.01										
UKR	Trawl	survey	West	-	Configuration						
BLACK SEA	TURBOT	Total	2013	COMBS EX	TUNING	DATA(ef fort	nos at age).	Importe d	from	VPA	file.
min	max	plusgroup	minyear	maxyear	startf	endf					
4	10	10	1989	2007	0.75	0.83					
Index	type	:	number								
UKR	Trawl	survey	West	-	Index	Values					
Units	:	NA									
age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	
4	24.77	13.12	41.04	37.77	29.37	28.20	NA	NA	NA	19.36	
5	35.74	13.83	29.7	33.15	53.37	51.25	NA	NA	NA	55.50	
6	41.02	18.13	28.8	38.03	34.73	33.35	NA	NA	NA	122.93	
7	20.92	19.68	21.6	28.01	33.2	31.88	NA	NA	NA	70.34	
8	10.15	11.69	4.68	6.42	29.37	28.20	NA	NA	NA	37.11	
9	9.54	8.71	4.14	5.4	25.03	24.03	NA	NA	NA	10.97	
10	8.94	5.84	0.9	1.03	5.62	5.40	NA	NA	NA	0.01	
age/year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**		
4	NA	NA	60.94	50.2	23.53	45.97	20.99	176.46	153.74		
5	NA	NA	77.7	89.77	60.51	60.23	45.17	114.86	121.44		
6	NA	NA	22.85	64.96	95.99	89.02	49.18	71.32	56.85		
7	NA	NA	4.57	53.15	139.68	104.56	95.17	50.48	39.62		
8	NA	NA	0.65	6.79	33.24	40.84	70.17	7.87	9.04		
9	NA	NA	0.65	1.48	1.87	12.85	13.61	10.19	12.06		
10	NA	NA	0.65	0.89	1.12	0.01	3.23	0.01	1.29		
BG	Trawl	survey	-	Configuration							
BLACK SEA	TURBOT	Total 2013	COMBS EX	TUNING	DATA (effort	nos at age).	Imported	from VPA	file.		
min	max	plusgroup	minyear	maxyear	startf	endf					
2	7	NA	2006	2014	0.5	0.5					
Index	type	:	number								
BG	Trawl	survey	-	Index	Values						
Units	:	NA									
age/ year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**		
2	222.36	124.13	171.01	19.95	5.10	38.33	9.85	NA	86.91		
3	259.03	233.08	118.97	139.66	7.66	38.33	19.71	NA	143.40		
4	108.80	328.24	215.63	136.59	24.24	26.35	26.28	NA	47.8		

5	41.40	204.12	270.15	155.01	57.42	16.77	13.14	NA	69.53		
6	24.84	86.89	161.10	102.83	37.00	26.35	9.85	NA	30.42		
7	10.65	13.79	19.83	30.70	17.86	21.56	6.57	NA	13.03		
TR CPUE	-	Configuration									
BLACK SEA	TURBOT	Total 2013	COMBS EX	TUNING	DATA(ef fort	nos at age).	Imported	from VPA	file.		
min	max	plusgroup	minyear	maxyear	startf	endf					
2	10	10	1987	2014	0.45	0.55					
Index	type	:	number								
TR	CPUE	-	Index	Values							
Units	:	NA									
age/ year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**		
2	0.9	1.1	138.2	342.5	649.5	223.1	648.3	922.4	516.8		
3	18.5	1.1	387.1	418.2	1109.9	152.4	544.0	2132.4	361.8		
4	129.7	4.5	481.8	642.3	805.1	154.9	223.9	1687.0	2395.4		
5	196.9	391.1	695.1	580.1	554.9	90.0	94.4	1539.3	3740.0		
6	745.8	591.9	797.8	227.1	432.2	70.5	38.5	472.9	1897.6		
7	217.7	489.7	406.8	179.4	334.4	79.5	21.9	335.5	669.3		
8	213.1	764.5	197.5	127.2	77.3	51.8	21.8	296.8	144.2		
9	134.3	172.6	185.6	79.4	56.2	11.9	17.0	252.9	18.8		
10	660.1	1113.3	616.1	218.5	56.2	12.8	4.8	77.5	18.8		
age/ year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**		
2	78.0	0.01	0.01	0.01	383.2	38.6	50.3	45.0	34.7		
3	82.7	139.9	30.4	133.8	342.4	57.7	97.5	78.5	88.4		
4	264.6	109.4	87.6	219.0	461.0	180.6	73.8	73.1	108.9		
5	343.2	97.9	249.9	146.0	374.9	335.8	86.9	122.4	134.0		
6	427.0	113.1	598.5	352.8	273.7	438.5	60.6	173.1	148.4		
7	197.3	154.4	329.8	279.8	687.4	141.0	43.1	185.6	101.3		
8	86.3	72.5	186.1	48.7	385.7	30.1	3.6	31.0	54.9		
9	20.3	30.4	38.1	24.3	198.2	3.5	0.8	1.7	6.2		
10	0.01	7.3	0.01	12.2	60.3	10.5	0.9	1.1	0.01		
age/ year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
2	95.2	192.5	174.8	97.0	60.9	10.7	64.2	19.9	37.8	92.4	
3	285.6	257.5	328.3	104.7	162.8	34.4	20.1	32.5	15.6	71.3	
4	292.4	348.8	623.2	234.7	182.6	119.7	18.1	53.6	56.7	63.0	
5	203.8	257.4	299.9	148.4	118.3	211.8	23.4	44.9	53.7	40.9	
6	97.9	157.3	153.7	99.5	68.3	177.3	10.1	15.8	21.4	27.2	
7	80.8	134.8	55.1	52.2	85.2	99.5	12.2	24.5	9.7	14.1	
8	53.5	25.7	7.2	18.1	14.0	46.4	13.9	15.0	5.1	3.0	
9	4.7	33.4	7.1	3.0	2.0	15.6	6.3	7.4	2.9	0.3	
10	1.5	0.01	0.8	1.2	0.01	3.8	1.9	1.9	0.3	0.01	
UKR	Trawl	survey	East -	Configuration							
BLACK	SEA	TURBOT	Total	2014	COMBS EX	TUNING	DATA(effo rt	nos at age).	Import ed	from	VPA file.
min	max	plusgroup	minyear	maxyear	startf	endf					

2	10	10	1989	2006	0.75	0.83					
Index	type	:	number								
UKR	Trawl	survey	East	-	Index	Values					
Units	:	NA									
age/ year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**		
2	2.22	0.94	6.01	11.43	4.45	7.06	NA	NA	NA		
3	6.21	1.69	2.8	14.95	8.74	13.87	NA	NA	NA		
4	7.73	4.32	10.42	11.75	9.31	14.77	NA	NA	NA		
5	11.15	4.55	13.21	10.31	16.92	26.85	NA	NA	NA		
6	12.8	5.97	12.56	11.83	11.01	17.47	NA	NA	NA		
7	6.53	6.48	6.96	8.71	10.53	16.7	NA	NA	NA		
8	3.17	3.85	1.73	2.00	9.31	14.77	NA	NA	NA		
9	2.98	2.87	1.79	1.68	7.93	12.59	NA	NA	NA		
10	2.79	1.92	0.36	0.32	1.78	2.83	NA	NA	NA		
age/ year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**		
2	0.01	NA	NA	0.01	0.01	0.25	0.75	0.46	0.21		
3	0.44	NA	NA	0.36	0.74	0.48	3.38	0.46	0.34		
4	1.12	NA	NA	1.45	1.38	0.98	5.80	2.09	1.33		
5	3.13	NA	NA	1.09	2.46	2.52	4.69	1.62	1.19		
6	9.38	NA	NA	2.91	1.78	4.00	4.36	1.39	0.75		
7	4.68	NA	NA	2.55	1.46	5.82	3.82	0.23	0.75		
8	3.13	NA	NA	0.73	0.19	1.39	2.99	0.01	0.13		
9	0.01	NA	NA	0.01	0.04	0.08	0.01	0.01	0.2		
10	0.01	NA	NA	0.01	0.02	0.05	0.01	0.01	0.01		
UKR	Trawl	survey	West	UKR	Trawl						
BLACK	SEA	TURBOT	Total	2014	COMBS EX	TUNING	DATA(effo rt	nos at age).	Import ed	from	VPA file.
min	max	plusgroup	minyear	maxyear	startf	endf					
4	10	10	1989	2007	0.75	0.83					
Index	type	:	number								
UKR	Trawl	survey	West	-	Index	Values					
Units	:	NA		2014	COMBS EX	TUNING	DATA(effo rt	nos at age).	Import ed	from	VPA file.
BLACK	SEA	TURBOT	Total	maxyear	startf	endf					
min	max	plusgroup	minyear	2006	0.75	0.83					
age/ year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**		
4	24.77	13.12	41.04	37.77	29.37	28.2	NA	NA	NA		
5	35.74	13.83	29.7	33.15	53.37	51.25	NA	NA	NA		
6	41.02	18.13	28.8	38.03	34.73	33.35	NA	NA	NA		
7	20.92	19.68	21.6	28.01	33.20	31.88	NA	NA	NA		
8	10.15	11.69	4.68	6.42	29.37	28.2	NA	NA	NA		
9	9.54	8.71	4.14	5.4	25.03	24.03	NA	NA	NA		
10	8.94	5.84	0.9	1.03	5.62	5.4	NA	NA	NA		
age/ year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
4	19.36	NA	NA	60.94	50.2	23.53	45.97	20.99	176.46	153.74	

5	55.50	NA	NA	77.7	89.77	60.51	60.23	45.17	114.86	121.44	
6	122.93	NA	NA	22.85	64.96	95.99	89.02	49.18	71.32	56.85	
7	70.34	NA	NA	4.57	53.15	139.68	104.56	95.17	50.48	39.62	
8	37.11	NA	NA	0.65	6.79	33.24	40.84	70.17	7.87	9.04	
9	10.97	NA	NA	0.65	1.48	1.87	12.85	13.61	10.19	12.06	
10	0.01	NA	NA	0.65	0.89	1.12	0.01	3.23	0.01	1.29	

5.2.2.7.3 Results

STECF EWG 15-12 evaluated the Black Sea Turbot stock applying the state-space assessment model (SAM) (Nielsen et al., 2012). The model configuration are similar to those, used for the assessment for the period 1950 - 2013. In the new assessment, turbot spawning biomass was estimated at 1st of May.

Black Sea turbot sam CONFIGURATION SETTINGS
name : Final Assessment
desc :
range : min max plusgroup minyear maxyear minfbar maxfbarrange
: 2 10 10 1950 2014 4 8
fleets : catch RO Trawl survey UKR Trawl survey West
fleets : 0 2 2
fleets : BG Trawl survey TR CPUE UKR Trawl survey East
fleets : 2 2 2
plus.group : TRUE
states : age
states : fleet 2 3 4 5 6 7 8 9 10
states : catch 1 2 3 4 5 6 7 7 7
states : RO Trawl survey NA NA NA NA NA NA NA NA NA
states : UKR Trawl survey West NA NA NA NA NA NA NA NA NA
states : BG Trawl survey NA NA NA NA NA NA NA NA NA
states : TR CPUE NA NA NA NA NA NA NA NA NA
states : UKR Trawl survey East NA NA NA NA NA NA NA NA NA
logN.vars: 1 2 2 2 2 2 2 2 2
catchabilities : age
catchabilities : fleet 2 3 4 5 6 7 8 9 10
catchabilities : catch NA NA NA NA NA NA NA NA NA
catchabilities : RO Trawl survey NA NA 3 3 3 3 4 5 NA
catchabilities : UKR Trawl survey West NA NA 6 7 8 9 10 11 12
catchabilities : BG Trawl survey 20 21 22 23 24 24 NA NA NA
catchabilities : TR CPUE 1 25 26 27 28 29 30 31 2
catchabilities : UKR Trawl survey East 13 14 15 16 17 18 18 18 19
power.law.exps: age
power.law.exps: fleet 2 3 4 5 6 7 8 9 10
power.law.exps: catch NA NA NA NA NA NA NA NA NA
power.law.exps:RO Trawl survey NA NA NA NA NA NA NA NA NA
power.law.exps: UKR Trawl survey West NA NA NA NA NA NA NA NA NA
power.law.exps : BG Trawl survey NA NA NA NA NA NA NA NA NA

power.law.exps: TR CPUE NA NA NA NA NA NA NA NA NA
power.law.exps: UKR Trawl Survey East NA NA NA NA NA NA NA NA NA
f.vars : age
f.vars : fleet 2 3 4 5 6 7 8 9 10
f.vars : catch 1 2 2 2 2 2 2 2 2
f.vars : RO Trawl survey NA NA NA NA NA NA NA NA NA
f.vars : UKR Trawl survey West NA NA NA NA NA NA NA NA NA
f.vars : BG Trawl survey NA NA NA NA NA NA NA NA NA
f.vars : TR CPUE NA NA NA NA NA NA NA NA NA
f.vars : UKR Trawl survey East NA NA NA NA NA NA NA NA NA
obs.vars: age
obs.vars : fleet 2 3 4 5 6 7 8 9 10
obs.vars : catch 1 2 3 4 5 6 7 7 8
obs.vars : RO Trawl survey NA NA 9 9 10 10 11 12 NA
obs.vars : UKR Trawl survey West NA NA 13 14 14 15 16 17 18
obs.vars: BG Trawl survey 26 27 28 29 30 31 NA NA NA
obs.vars: TR CPUE 32 33 34 35 36 37 37 37 38
obs.vars: UKR Trawl survey East 19 20 21 22 22 22 23 24 25
srr: 0
cor.F : FALSE
nohess : FALSE
timeout : 3600

Black Sea turbot FLR R SOFTWARE VERSIONS

FLSAM.version 0.99-9
FLCore.version 2.5.2000
R.version R version 2.15.0 (2012-03-30)
platform i386-pc-mingw32
run.date 1.10.2015 10:29:13

SAM outputs and model diagnostics are listed in the tables below.

Table 5.2.2.7.3.1. Turbot in GSA 29. Summary table of the final SAM model.

Year	Rec Age 2	Low	High	TSB	Low	High	SSB	Low	High	Fbar (4-8)	Low	High	Land-ings (t)	Lan-dings SOP
1950	1973	1344	2897	16757	13919	20175	10594	8683	12924	0.48	0.35	0.66	3932	1
1951	1907	1341	2712	16505	13931	19554	10425	8670	12536	0.52	0.40	0.68	4741	1
1952	1740	1218	2485	15621	13177	18519	9783	8149	11744	0.57	0.45	0.73	5217	1
1953	1909	1354	2690	14490	12202	17207	8768	7305	10524	0.61	0.48	0.77	4985	1
1954	2054	1461	2887	13512	11375	16050	7784	6497	9326	0.66	0.52	0.83	4505	1
1955	1980	1398	2804	12726	10687	15155	7093	5938	8472	0.69	0.55	0.86	3678	1
1956	1873	1320	2657	12212	10218	14597	6777	5671	8099	0.73	0.57	0.92	3623	1
1957	1851	1310	2615	11917	9950	14273	6799	5685	8133	0.63	0.50	0.80	3017	1
1958	1916	1368	2683	12038	10099	14349	6799	5705	8104	0.68	0.54	0.85	4289	1

1959	1777	1265	2495	11699	9856	13888	6556	5523	7783	0.71	0.56	0.90	4653	1
1960	1683	1193	2372	11187	9433	13267	6404	5398	7598	0.64	0.51	0.81	2680	1
1961	1641	1162	2317	11086	9366	13120	6465	5456	7662	0.64	0.51	0.82	3058	1
1962	1622	1143	2303	11042	9336	13060	6481	5470	7678	0.64	0.50	0.81	2904	1
1963	1726	1225	2432	11040	9331	13063	6293	5310	7458	0.70	0.55	0.88	3812	1
1964	1631	1161	2289	10613	8954	12579	5989	5050	7104	0.70	0.55	0.88	3666	1
1965	1923	1383	2673	10545	8902	12492	5809	4885	6909	0.68	0.53	0.86	3063	1
1966	1975	1420	2748	10832	9144	12833	5899	4946	7036	0.67	0.52	0.88	3093	1
1967	2023	1453	2816	11298	9502	13434	6269	5221	7526	0.58	0.43	0.79	2709	1
1968	1751	1259	2434	11842	9916	14141	7008	5783	8492	0.50	0.36	0.68	2931	1
1969	1388	991	1942	12190	10135	14663	7758	6317	9529	0.43	0.31	0.59	3076	1
1970	1042	743	1461	12115	9948	14755	8004	6364	10067	0.50	0.36	0.69	5273	1
1971	845	602	1187	11015	8825	13749	7686	5890	10031	0.41	0.29	0.58	3052	1
1972	911	656	1266	10405	8068	13418	7265	5283	9991	0.42	0.29	0.61	3049	1
1973	994	721	1369	9759	7265	13109	6619	4484	9771	0.45	0.30	0.68	3705	1
1974	1338	978	1833	9388	6748	13062	6265	4006	9798	0.33	0.21	0.53	1696	1
1975	1492	1093	2035	10169	7292	14180	6792	4326	10663	0.26	0.16	0.40	1273	1
1976	1608	1180	2192	11636	8498	15935	7841	5145	11949	0.23	0.15	0.35	1584	1
1977	1431	1057	1938	13090	9748	17577	9148	6250	13389	0.23	0.15	0.35	2012	1
1978	1209	884	1653	14223	10759	18801	10340	7309	14629	0.25	0.17	0.35	2160	1
1979	790	559	1115	14638	11117	19274	10895	7848	15125	0.32	0.23	0.45	5447	1
1980	438	294	652	13499	10198	17869	10586	7644	14660	0.28	0.21	0.39	2843	1
1981	275	195	389	12356	9155	16677	9954	7086	13983	0.30	0.22	0.40	3276	1
1982	209	151	289	10776	7751	14983	8652	5964	12553	0.37	0.28	0.49	4662	1
1983	218	162	292	8626	5941	12523	6741	4390	10349	0.51	0.37	0.70	5307	1
1984	212	159	282	6323	4081	9795	5024	3026	8340	0.46	0.32	0.67	2852	1
1985	223	168	297	5027	3090	8176	4173	2403	7250	0.23	0.15	0.35	527	1
1986	249	188	330	4723	2938	7592	3956	2310	6777	0.15	0.09	0.23	428	1
1987	279	209	374	4681	3031	7229	3717	2265	6100	0.20	0.15	0.28	849	1
1988	322	237	439	4292	2950	6245	3159	2057	4850	0.29	0.22	0.38	1116	1
1989	469	347	634	4068	3007	5502	2615	1828	3743	0.44	0.34	0.56	1460	1
1990	732	546	982	3540	2846	4405	2050	1582	2658	0.53	0.41	0.68	1393	1
1991	1125	828	1528	3693	3126	4363	1850	1547	2213	0.52	0.40	0.68	935	1
1992	1350	974	1871	5534	4663	6569	2775	2356	3268	0.36	0.26	0.48	439	1
1993	1328	947	1862	5784	4849	6899	3046	2574	3604	0.36	0.28	0.48	1603	1
1994	1126	831	1525	6340	5351	7512	3687	3097	4391	0.59	0.46	0.74	2144	1
1995	930	692	1249	6642	5657	7797	4104	3458	4869	0.74	0.59	0.94	2943	1
1996	668	494	903	6335	5458	7352	3832	3252	4516	0.77	0.62	0.96	2048	1
1997	694	505	953	5899	5100	6823	3647	3119	4264	0.69	0.55	0.87	1025	1
1998	802	592	1086	6267	5436	7224	3838	3293	4474	0.59	0.47	0.75	1588	1
1999	756	561	1019	6169	5317	7157	3624	3063	4288	0.63	0.50	0.78	1953	1
2000	656	486	887	5419	4627	6347	2876	2436	3397	1.03	0.85	1.24	2789	1
2001	593	442	793	4794	4115	5585	2597	2220	3038	1.24	1.04	1.47	2557	1
2002	656	485	888	4328	3736	5014	2557	2199	2974	0.84	0.69	1.01	1567	1
2003	868	651	1159	4196	3633	4846	2324	2009	2689	0.75	0.62	0.91	1122	1
2004	1210	899	1629	4927	4214	5761	2344	2029	2709	0.80	0.66	0.97	1142	1

2005	1373	1002	1880	5473	4632	6466	2594	2234	3013	0.77	0.63	0.93	1400	1
2006	1339	967	1855	6884	5751	8241	3301	2811	3876	0.87	0.72	1.04	1751	1
2007	1116	802	1555	6579	5491	7882	3562	3021	4200	0.76	0.61	0.93	2259	1
2008	889	629	1256	6023	5059	7171	3552	3020	4178	0.83	0.67	1.02	2122	1
2009	768	546	1079	5497	4680	6456	3323	2842	3884	0.71	0.58	0.87	2078	1
2010	639	449	910	4493	3805	5306	2628	2239	3085	0.74	0.61	0.90	1738	1
2011	611	411	908	3730	3129	4447	2141	1804	2540	0.79	0.65	0.96	1659	1
2012	543	346	854	3499	2890	4234	1939	1612	2332	1.03	0.86	1.23	1714	1
2013	661	370	1179	2466	1980	3072	1292	1061	1574	1.34	1.12	1.60	1522	1
2014	716	344	1493	1973	1447	2691	1010	759	1345	1.40	1.01	1.94	1159	1

Table 5.2.2.7.3.2. Black Sea turbot. Estimated fishing mortality.

		Black	Sea turbot							
	ESTIMATED		FISHING	MORTALITY						
Units	:	f								
Age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**
2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
3	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.13
4	0.20	0.21	0.23	0.25	0.26	0.25	0.25	0.26	0.29	0.31
5	0.34	0.38	0.43	0.49	0.52	0.57	0.50	0.48	0.51	0.49
6	0.41	0.45	0.51	0.56	0.62	0.64	0.75	0.66	0.67	0.71
7	0.58	0.65	0.71	0.73	0.79	0.85	0.88	0.70	0.86	0.88
8	0.87	0.92	0.98	1.01	1.09	1.13	1.26	1.04	1.07	1.17
9	0.87	0.92	0.98	1.01	1.09	1.13	1.26	1.04	1.07	1.17
10+	0.87	0.92	0.98	1.01	1.09	1.13	1.26	1.04	1.07	1.17
Age/year	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**
2	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.03	0.02	0.03
3	0.13	0.13	0.13	0.14	0.14	0.14	0.13	0.13	0.12	0.12
4	0.28	0.28	0.29	0.28	0.29	0.27	0.26	0.22	0.21	0.19
5	0.40	0.35	0.34	0.39	0.41	0.42	0.39	0.36	0.31	0.34
6	0.64	0.60	0.56	0.65	0.67	0.62	0.69	0.58	0.54	0.44
7	0.74	0.73	0.73	0.88	0.86	0.82	0.88	0.73	0.65	0.60
8	1.16	1.26	1.29	1.28	1.26	1.25	1.16	1.02	0.77	0.57
9	1.16	1.26	1.29	1.28	1.26	1.25	1.16	1.02	0.77	0.57
10+	1.16	1.26	1.29	1.28	1.26	1.25	1.16	1.02	0.77	0.57
Age/year	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
2	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01
3	0.11	0.09	0.08	0.06	0.05	0.05	0.05	0.06	0.07	0.08
4	0.17	0.15	0.11	0.09	0.06	0.05	0.05	0.05	0.05	0.06
5	0.38	0.34	0.35	0.34	0.24	0.23	0.20	0.17	0.20	0.25
6	0.51	0.46	0.46	0.53	0.45	0.37	0.30	0.28	0.27	0.35
7	0.81	0.64	0.70	0.85	0.59	0.42	0.39	0.41	0.44	0.61
8	0.63	0.49	0.47	0.43	0.32	0.21	0.21	0.26	0.27	0.35
9	0.63	0.49	0.47	0.43	0.32	0.21	0.21	0.26	0.27	0.35
10+	0.63	0.49	0.47	0.43	0.32	0.21	0.21	0.26	0.27	0.35
Age/year	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**

2	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
3	0.09	0.10	0.10	0.09	0.06	0.03	0.02	0.02	0.02	0.04
4	0.07	0.08	0.10	0.11	0.08	0.05	0.03	0.04	0.04	0.08
5	0.24	0.24	0.40	0.66	0.39	0.16	0.11	0.13	0.17	0.26
6	0.33	0.33	0.39	0.61	0.72	0.30	0.21	0.30	0.34	0.48
7	0.45	0.48	0.57	0.76	0.78	0.46	0.27	0.26	0.41	0.61
8	0.32	0.36	0.39	0.39	0.33	0.18	0.12	0.28	0.49	0.75
9	0.32	0.36	0.39	0.39	0.33	0.18	0.12	0.28	0.49	0.75
10+	0.32	0.36	0.39	0.39	0.33	0.18	0.12	0.28	0.49	0.75
Age/year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
2	0.06	0.06	0.05	0.19	0.12	0.06	0.02	0.00	0.00	0.00
3	0.05	0.06	0.07	0.08	0.09	0.09	0.08	0.09	0.08	0.09
4	0.13	0.17	0.17	0.19	0.21	0.23	0.20	0.17	0.17	0.17
5	0.38	0.45	0.32	0.31	0.36	0.45	0.37	0.23	0.22	0.27
6	0.41	0.41	0.33	0.31	0.38	0.54	0.62	0.43	0.46	0.48
7	0.72	0.62	0.32	0.32	0.52	0.74	0.69	0.58	0.74	1.17
8	0.99	0.95	0.64	0.69	1.46	1.75	1.98	2.06	1.37	1.03
9	0.99	0.95	0.64	0.69	1.46	1.75	1.98	2.06	1.37	1.03
10+	0.99	0.95	0.64	0.69	1.46	1.75	1.98	2.06	1.37	1.03
Age/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2	0.04	0.06	0.12	0.04	0.02	0.04	0.07	0.11	0.17	0.10
3	0.10	0.12	0.13	0.13	0.13	0.13	0.14	0.16	0.17	0.18
4	0.18	0.20	0.22	0.21	0.22	0.24	0.25	0.31	0.36	0.37
5	0.30	0.35	0.35	0.35	0.36	0.40	0.38	0.39	0.50	0.56
6	0.60	0.79	0.56	0.56	0.63	0.56	0.62	0.57	0.49	0.53
7	2.00	2.49	1.38	1.18	0.83	1.02	1.49	0.93	0.99	0.98
8	2.08	2.37	1.68	1.46	1.94	1.61	1.60	1.57	1.80	1.12
9	2.08	2.37	1.68	1.46	1.94	1.61	1.60	1.57	1.80	1.12
10+	2.08	2.37	1.68	1.46	1.94	1.61	1.60	1.57	1.80	1.12
Age/year	**2010**	**2011**	**2012**	**2013**	**2014**					
2	0.04	0.31	0.27	0.22	0.32					
3	0.17	0.19	0.21	0.23	0.23					
4	0.36	0.33	0.38	0.48	0.55					
5	0.63	0.67	0.61	0.74	0.82					
6	0.63	0.54	0.67	0.72	0.79					
7	0.90	0.85	1.32	1.34	1.05					
8	1.19	1.55	2.16	3.42	3.80					
9	1.19	1.55	2.16	3.42	3.80					
10+	1.19	1.55	2.16	3.42	3.80					

Table 5.2.2.7.3.3. Turbot in GSA 29. Estimated population aundance.

		Black	Sea	turbot					
	ESTIMATED POPULATION ABUNDANCE								
Units	:	NA							
Age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
2	1973.4	1907.0	1739.8	1908.7	2053.9	1979.7	1872.8	1850.8	1915.6

3	2021.9	1746.9	1686.3	1520.7	1681.3	1819.7	1749.9	1651.6	1633.9
4	1623.3	1657.4	1428.7	1373.5	1222.1	1362.7	1480.9	1413.7	1321.6
5	1233.7	1189.8	1203.4	1019.6	963.9	837.1	953.0	1044.7	975.6
6	790.6	790.2	735.5	703.0	558.2	514.7	423.5	518.1	583.1
7	438.2	473.3	454.5	396.9	360.7	268.8	243.9	179.2	241.3
8	220.8	221.4	223.2	201.3	171.8	146.9	103.7	91.1	79.9
9	77.0	83.5	79.5	75.3	65.8	52.1	42.7	26.4	28.9
10+	48.9	47.6	47.0	42.6	38.6	31.7	24.3	17.1	13.8
Age/year	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	1776.9	1682.6	1640.7	1622.1	1726.4	1630.6	1922.5	1975.2	2022.7
3	1695.4	1555.9	1476.3	1453.6	1429.2	1513.8	1420.6	1711.1	1741.0
4	1294.1	1343.5	1227.6	1161.7	1141.1	1109.8	1179.3	1099.3	1357.6
5	884.6	852.6	914.2	829.1	783.1	774.2	746.1	809.4	758.5
6	523.4	484.1	512.1	582.3	528.8	475.5	461.2	437.2	493.6
7	269.0	230.5	230.3	253.8	302.3	249.1	219.3	223.3	196.9
8	92.2	100.7	99.5	100.1	109.9	112.8	94.9	87.4	83.3
9	24.7	25.7	28.5	25.3	24.9	27.5	28.7	24.6	24.6
10+	13.2	10.6	10.3	9.9	8.8	8.4	9.2	9.8	9.7
Age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	1750.6	1387.6	1041.8	845.4	911.1	993.6	1338.5	1491.6	1608.4
3	1768.3	1532.1	1209.7	889.1	745.2	810.9	876.8	1199.9	1336.4
4	1374.0	1406.8	1221.5	971.8	723.5	611.6	681.7	742.9	1033.5
5	982.8	998.7	1046.8	929.1	747.5	578.8	498.8	578.2	628.8
6	474.9	650.8	636.6	642.6	599.3	473.3	366.0	350.7	414.4
7	249.8	248.6	381.0	344.2	366.5	340.0	249.1	209.9	217.0
8	85.0	117.8	122.5	152.2	164.4	163.2	129.7	124.2	124.2
9	27.0	35.2	60.2	58.9	84.3	92.9	95.3	84.2	90.3
10+	11.1	15.9	26.1	41.6	55.7	79.2	100.6	127.8	154.4
Age/year	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	1431.0	1209.1	789.5	438.0	275.2	209.3	217.5	212.0	223.0
3	1428.2	1261.1	1071.1	704.1	379.2	236.2	185.0	194.5	188.6
4	1140.2	1214.9	1060.1	895.3	582.3	305.8	188.7	150.3	164.8
5	891.6	981.7	1039.6	894.0	757.3	487.4	245.8	149.3	122.0
6	461.5	687.2	723.5	729.3	632.9	540.2	295.8	111.5	89.3
7	276.1	313.6	481.1	458.8	470.5	411.8	333.2	144.5	47.7
8	132.1	165.5	182.9	236.2	264.5	263.5	209.2	140.5	59.4
9	90.6	92.0	114.1	115.5	154.4	166.4	161.0	127.2	90.7
10+	178.4	187.5	192.2	193.7	201.9	223.8	238.0	242.2	238.7
Age/year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	249.0	279.2	322.3	469.1	732.2	1124.5	1350.1	1327.6	1125.5
3	198.5	222.1	249.1	286.1	409.7	614.4	953.5	1157.5	977.3
4	163.8	175.0	195.6	221.2	244.3	345.2	513.1	801.4	955.4
5	141.4	143.5	151.6	171.7	183.9	188.0	256.3	386.2	603.0
6	92.8	115.1	114.8	114.7	119.7	112.8	105.4	166.6	253.1
7	59.2	68.5	76.7	73.9	63.0	72.4	66.7	66.4	110.5
8	26.7	41.0	48.1	45.9	36.1	27.3	35.1	43.7	43.2

9	44.3	21.5	27.8	26.5	19.5	12.0	9.4	16.7	20.0
10+	246.7	232.5	172.3	109.8	57.6	25.6	13.0	10.7	12.5
Age/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	929.7	667.7	693.8	801.5	756.4	656.4	592.5	655.9	868.2
3	891.2	780.8	573.8	620.5	724.1	681.4	539.8	477.8	500.0
4	795.1	731.4	646.1	462.8	517.0	600.6	539.3	416.0	361.4
5	695.5	559.5	536.4	493.7	348.4	393.4	442.3	389.4	291.0
6	381.3	395.6	343.8	386.4	362.9	238.5	256.6	273.4	240.3
7	157.5	200.5	189.2	200.5	219.1	204.8	114.4	102.8	138.3
8	58.8	67.4	90.5	95.8	86.1	61.1	24.2	8.3	22.8
9	8.9	9.2	8.3	10.4	22.0	28.0	6.7	2.0	1.4
10+	6.7	2.4	1.4	1.1	2.7	7.9	4.0	0.9	0.5
Age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	1210.2	1372.9	1339.3	1116.3	888.6	767.5	639.1	610.7	543.2
3	722.3	1030.9	1147.2	1083.0	860.5	644.0	599.9	534.1	386.8
4	379.8	551.4	792.1	871.8	805.6	631.0	462.2	444.7	388.0
5	256.6	266.1	382.3	544.4	551.9	490.0	381.0	279.3	283.3
6	179.6	156.3	156.4	228.2	324.6	290.8	243.8	176.7	124.1
7	119.7	82.5	78.3	73.2	113.2	177.1	149.3	113.4	90.5
8	37.1	46.3	26.1	15.4	25.3	36.9	58.5	53.5	42.6
9	4.7	4.6	8.2	4.6	2.8	3.7	10.6	15.8	10.0
10+	0.4	0.6	0.9	1.6	1.1	0.6	1.2	3.2	3.5
Age/year	**2013**	**2014**							
2	660.7	716.2							
3	356.4	460.6							
4	274.2	246.3							
5	231.6	148.4							
6	135.4	97.6							
7	55.4	58.2							
8	21.2	12.6							
9	4.3	0.6							
10+	1.4	0.2							

Table 5.2.2.7.3.4. Turbot in GSA 29. Catch at age residuals.

TABLE	2.6.3.16	Black	Sea	turbot					
	CATCH	AT	AGE	RESIDUALS					
Units	:	NA							
age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
2	-0.05	-0.01	0.04	0.05	-0.01	-0.02	0.02	-0.10	-0.02
3	-0.30	-0.06	0.09	0.19	-0.03	-0.20	-0.21	-0.19	0.31
4	-0.29	-0.16	0.15	0.22	0.07	-0.13	-0.22	-0.06	0.20
5	-0.34	-0.09	0.08	0.36	0.02	-0.05	-0.15	0.04	0.48
6	-0.25	0.00	0.17	0.03	0.13	-0.19	-0.01	-0.19	0.30
7	-0.11	0.07	0.11	-0.04	0.03	-0.03	0.31	-0.62	0.26
8	-0.11	0.16	0.07	-0.11	0.11	-0.18	0.33	-0.57	0.23
9	-0.03	0.09	0.19	0.03	0.13	0.05	0.29	-0.56	-0.01

10+	-0.05	0.09	0.07	-0.01	0.04	-0.05	0.10	-0.41	-0.01
age/year	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.14	0.15	-0.29	-0.11	0.29	0.07	-0.29	-0.08	0.28
3	0.51	-0.19	-0.20	-0.19	0.23	0.54	-0.02	-0.31	0.20
4	0.60	-0.32	-0.04	0.03	-0.13	0.19	0.20	-0.14	-0.09
5	0.37	-0.48	-0.20	-0.52	0.16	0.16	0.14	0.13	-0.37
6	0.32	-0.39	-0.10	-0.21	0.43	0.07	-0.38	0.30	-0.16
7	0.29	-0.25	-0.06	-0.19	0.41	-0.01	-0.20	0.32	-0.26
8	0.11	-0.23	0.18	0.08	0.39	0.11	0.12	0.37	0.11
9	0.15	-0.41	0.04	-0.03	-0.18	-0.09	-0.21	-0.32	-0.22
10+	0.19	0.23	0.34	-0.23	0.09	0.03	0.29	0.18	0.20
age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	-0.04	-0.07	0.72	-0.55	-0.15	0.23	0.15	-1.19	0.76
3	0.37	0.58	0.88	-0.35	0.25	0.00	-1.61	-1.26	0.23
4	0.27	0.48	-0.04	1.30	-0.41	0.28	-1.57	-0.21	-0.32
5	-0.38	-0.09	0.98	-0.41	-0.05	0.99	-1.51	0.48	-0.06
6	-0.11	-0.38	0.59	-0.40	-0.03	0.56	-0.45	-0.09	-0.23
7	0.02	-0.52	0.87	-0.45	-0.05	0.66	-0.22	-0.40	-0.18
8	0.22	-0.33	0.78	-0.51	0.39	0.64	0.11	-0.27	-0.30
9	-0.63	-0.95	0.65	-0.45	-0.11	0.18	-0.21	-1.36	-0.47
10+	-0.11	-0.14	0.98	0.02	0.37	0.48	0.32	-0.65	0.16
age/year	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	0.09	0.27	-0.51	0.25	0.99	-0.86	-0.13	-0.01	-0.02
3	-0.36	-0.13	0.55	0.25	0.65	1.35	1.93	1.36	-1.58
4	-0.87	-0.19	0.59	-0.32	-0.58	0.98	1.79	1.56	-1.27
5	-1.04	0.24	1.14	-0.20	-1.31	0.51	2.17	-0.01	-2.50
6	-0.30	-0.30	1.13	-0.04	-0.48	0.07	1.15	0.74	-2.19
7	0.06	-0.33	1.11	-0.40	-0.11	0.03	0.73	0.46	-0.56
8	0.07	-0.37	0.74	-0.41	0.32	-0.10	0.32	1.03	-0.49
9	0.43	-0.14	0.85	-0.32	0.25	0.59	0.63	0.53	-0.31
10+	0.40	-0.21	0.52	0.02	0.27	0.63	0.55	0.48	-0.26
age/year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	-0.03	-0.13	-0.87	0.61	0.37	0.20	-0.34	0.77	0.04
3	-3.42	-1.02	-3.62	1.01	1.03	0.99	-0.58	1.15	1.03
4	-3.35	0.32	-3.75	1.02	1.37	0.58	-1.01	0.17	0.28
5	-1.90	-0.46	-0.29	0.84	0.96	-0.11	-2.44	-0.81	0.30
6	-2.39	1.18	-0.15	1.13	-0.07	0.59	-1.72	-1.10	-0.41
7	-0.66	-0.41	0.03	0.44	-0.30	0.78	-0.81	-0.93	0.22
8	-4.59	0.64	1.38	-0.58	-0.09	-1.17	-0.85	-0.63	0.39
9	-1.08	0.98	-0.33	0.31	0.18	-0.26	-1.13	0.66	1.50
10+	0.13	-0.19	-0.11	-0.04	0.02	-0.69	-0.67	-0.35	0.09
age/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	0.24	1.23	-1.39	-0.52	-1.56	1.65	-0.21	0.23	-0.20
3	-0.31	-0.31	0.25	-1.32	0.14	0.37	-0.22	0.86	-0.25
4	0.74	0.04	-0.72	-1.05	0.41	0.39	0.42	0.52	-0.53
5	1.29	0.06	-1.59	-0.42	-0.03	0.22	1.26	0.53	-0.34

6	1.12	0.43	-1.89	0.58	0.76	-0.58	2.05	-0.20	-0.08
7	0.59	0.11	-0.79	-0.20	0.04	0.89	0.18	-0.08	0.61
8	-1.66	-0.51	-1.56	-0.41	-1.34	1.41	0.09	-0.14	0.02
9	-1.93	0.49	1.19	0.74	-0.12	1.62	-1.47	-0.31	-0.08
10+	-0.61	-4.00	0.75	-3.36	1.04	0.74	0.62	0.64	0.39
age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	-0.23	0.06	0.13	0.05	-0.01	0.21	-0.91	0.75	-0.81
3	-0.39	0.20	-0.10	0.32	0.08	0.64	-0.87	0.07	0.27
4	-0.13	0.39	0.03	0.69	0.34	0.34	-0.26	-0.36	0.32
5	0.11	0.54	0.18	0.34	-0.07	-0.36	0.16	-0.32	0.13
6	0.18	-0.42	0.27	0.23	0.27	-0.42	0.82	-0.94	-0.48
7	-0.47	-0.79	0.77	-0.73	0.18	0.65	0.16	-0.53	0.73
8	0.08	-0.37	-0.83	-1.58	0.32	-0.37	0.08	0.84	0.36
9	-0.12	-0.62	1.75	0.55	1.05	0.29	1.19	1.61	1.71
10+	-1.83	0.39	-2.81	-0.67	0.40	-1.94	1.09	0.98	0.49
age/year	**2013**	**2014**							
2	0.13	0.26							
3	-0.13	0.54							
4	0.81	0.50							
5	1.13	0.48							
6	0.61	0.67							
7	-0.17	-0.10							
8	-0.15	-0.83							
9	1.75	0.71							
10+	-0.10	-1.37							

Table 5.2.2.7.3.5. Turbot in GSA 29. Index at age, residuals (TR CPUE).

TABLE	2.6.3.19	Black	Sea	turbot				
INDEX	AT	AGE	RESIDUALS	TR	CPUE			
Units	:	NA						
age/year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	-0.90	-0.88	0.67	0.84	0.92	0.48	0.88	1.05
3	-0.65	-2.94	1.55	1.33	1.79	-0.12	0.74	1.95
4	0.52	-2.59	1.50	1.70	1.60	-0.23	-0.29	1.37
5	0.65	1.28	1.76	1.58	1.54	-0.58	-0.93	1.36
6	1.64	1.47	1.78	0.67	1.25	-0.23	-1.13	0.64
7	0.76	1.54	1.49	0.88	1.32	-0.19	-1.50	0.85
8	0.84	2.07	0.88	0.80	0.56	-0.25	-1.32	1.71
9	0.65	0.75	1.01	0.58	0.70	-0.78	-0.98	1.96
10	0.35	0.86	0.85	0.70	0.40	-0.13	-0.54	1.10
age/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2	0.90	0.35	-2.56	-2.47	-2.59	0.92	0.16	0.23
3	0.62	-0.44	0.22	-1.04	0.00	0.81	-0.40	0.11
4	1.86	-0.05	-0.75	-0.65	0.08	0.62	-0.11	-0.67
5	2.13	-0.02	-1.26	-0.28	-0.44	0.39	0.20	-0.99
6	1.52	0.28	-0.78	0.52	0.14	0.34	0.75	-1.05

7	1.30	-0.20	-0.45	0.34	0.30	1.71	0.94	-0.70
8	0.82	0.28	-0.15	0.39	-1.02	1.95	0.46	-0.96
9	0.30	0.46	1.01	0.66	-0.72	1.70	-0.78	-1.43
10	0.74	-2.36	1.15	-1.88	0.82	1.38	0.89	0.21
age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2	0.08	-0.13	0.18	0.44	0.48	0.36	0.24	-0.32
3	-0.10	-0.29	0.35	0.19	0.43	-0.28	0.30	-0.87
4	-0.56	-0.24	0.32	0.16	0.62	-0.17	-0.17	-0.27
5	-0.38	-0.16	0.22	0.09	-0.10	-0.74	-0.81	0.03
6	-0.06	0.08	-0.18	0.24	-0.12	-0.81	-1.01	-0.03
7	0.37	-0.27	-0.03	0.78	-0.34	-0.80	-0.77	-0.48
8	0.09	0.42	0.00	-0.16	-0.92	-0.39	-1.37	-0.59
9	-0.34	-0.07	-0.51	0.90	-0.11	-0.35	-1.37	-0.34
10	0.55	-0.85	0.62	-1.55	-0.26	0.21	-1.80	0.66
age/year	**2011**	**2012**	**2013**	**2014**				
2	0.37	-0.01	0.14	0.44				
3	-1.20	-0.56	-1.06	-0.07				
4	-1.94	-0.82	-0.42	-0.20				
5	-1.79	-1.20	-0.77	-0.56				
6	-2.19	-1.46	-1.26	-0.76				
7	-2.34	-1.17	-1.60	-1.42				
8	-1.53	-0.91	-0.67	-0.48				
9	-1.47	-0.54	0.01	0.00				
10	-0.15	-0.02	-0.18	-0.77				

Table 5.2.2.7.3.6. Turbot in GSA 29. Index at age residuals. UKR Trawl survey West.

TABLE	2.6.3.21	Black	Sea	turbot			
INDEX	AT	AGE	RESIDUALS	UKR	Trawl	survey	West
Units	:	NA					
age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	0.39	-0.69	0.59	-0.15	-1.22	-1.52	-1.03
5	0.36	-1.61	0.08	-0.56	-0.42	-1.39	-1.03
6	0.63	-1.33	-0.20	0.41	-0.81	-1.68	0.36
7	-0.86	-0.61	-0.78	-0.63	-0.40	-0.92	-0.42
8	-0.98	-0.47	-1.07	-1.24	-0.03	0.50	-0.04
9	-1.29	-0.90	-1.18	-0.93	0.01	0.38	0.19
10	-0.59	-0.39	-0.93	-0.65	0.31	0.51	-1.44
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	0.58	0.71	-0.26	0.72	-1.06	1.70	1.41
5	0.20	0.79	0.56	0.84	0.20	1.40	0.78
6	-1.78	-0.06	1.06	1.64	0.55	1.44	0.06
7	-1.47	0.80	1.48	0.92	1.49	1.21	0.39
8	-1.72	0.88	1.24	1.33	1.39	-0.08	0.50
9	-1.29	0.11	0.53	1.54	1.36	0.54	1.21
10	0.40	1.03	1.37	-0.66	1.80	-1.24	0.87

Table 5.2.2.7.3.7. Turbot in GSA 29. Index at age residuals. UKR Trawl survey East.

		Black	Sea	turbot			
INDEX	AT	AGE	RESIDUALS	UKR	Trawl	survey	East
Units	:	NA					
age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
2	0.95	0.40	1.02	1.22	0.87	1.11	-1.64
3	1.51	0.30	0.38	1.29	0.76	1.23	-0.97
4	1.37	0.75	1.30	1.03	0.38	0.68	-1.17
5	1.31	0.48	1.52	0.89	0.97	1.03	-0.94
6	1.27	0.45	1.22	1.17	0.64	0.74	-0.19
7	0.45	0.67	0.53	0.60	0.78	0.89	-0.72
8	0.19	0.56	0.24	0.03	0.82	1.45	0.04
9	0.42	0.66	0.65	0.61	1.13	1.59	-1.77
10	-0.40	0.01	-0.78	-0.51	1.20	2.01	-0.88
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
2	-1.47	-1.50	-0.25	0.08	-0.18	-0.50	
3	-0.97	-0.35	-0.70	0.46	-1.26	-1.55	
4	-1.02	-0.80	-1.00	0.69	-0.65	-1.44	
5	-1.72	-0.82	-0.53	0.20	-0.83	-1.48	
6	-0.66	-1.36	-0.46	-0.05	-1.06	-1.60	
7	0.57	-0.70	0.18	-0.34	-2.53	-1.00	
8	0.47	-0.01	0.46	0.84	-2.75	-0.93	
9	-1.13	-0.07	0.39	-1.12	-1.25	-0.01	
10	-1.28	0.17	1.36	0.49	-0.21	-0.53	

Table 5.2.2.7.3.8. Turbot in GSA 29. Index at age residuals. RO Trawl survey.

		Black	Sea	turbot			
INDEX	AT	AGE	RESIDUALS	RO	Trawl	survey	
Units	:	NA					
age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4	-1.00	-1.46	-0.87	-1.16	0.08	0.16	-0.55
5	-0.53	0.33	0.35	0.98	-0.82	-0.82	-0.26
6	0.37	0.95	-0.84	0.00	-1.38	-1.63	-0.39
7	0.92	-0.80	0.13	-0.15	-0.17	-0.88	0.06
8	-1.25	0.90	0.86	-1.27	-1.12	-1.23	0.75
9	-0.44	-0.83	-0.90	-1.12	-0.90	-0.66	1.85
age/year	**2010**	**2011**	**2012**	**2013**	**2014**		
4	0.08	0.99	0.64	-0.02	-1.08		
5	0.30	2.09	2.10	-0.53	-0.49		
6	-0.33	0.89	2.10	-0.21	-0.15		
7	-0.29	0.91	2.49	0.72	0.61		
8	0.56	0.94	0.95	-0.94	0.94		
9	0.89	1.19	1.27	-0.51	0.34		

Table 5.2.2.7.3.9. Turbot in GSA 29. Index at age residuals. BG Trawl survey.

		Black	Sea	turbot				

INDEX	AT	AGE	RESIDUALS	BG	Trawl	survey		
Units	:	NA						
Age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**
2	0.94	0.60	1.12	-0.69	-1.77	0.18	-0.94	0.77
3	0.70	0.66	0.24	0.68	-2.10	-0.40	-0.73	1.06
4	-0.07	1.36	0.92	0.64	-1.32	-1.18	-0.96	0.61
5	-0.69	0.72	1.09	0.62	-0.18	-1.20	-1.52	1.21
6	-0.34	1.08	1.45	0.92	-0.41	-0.51	-1.46	0.93
7	0.22	0.37	0.24	0.19	-1.04	0.27	-1.90	1.06

The SAM estimated four peaks of recruitment in 1965 – 1968, 1974 – 1978, 1991 – 1994 and 2004 – 2007 and three lows in 1982-84, 1996 – 1997 and after 2009. Correspondingly, SSB attained higher values up to 12 689 t in 1977 – 1982 and very low values after 2009. For the period after 2002, STECF EWG 15 12 is aware that misreporting of actual catches might be larger than assumed in the assessment (around 4.7 the official catches of Bulgaria, Romania and Ukraine). Fishing mortality reached its peak (F = 1.4) during recent years (2012 – 2014) (Fig. 5.2.2.7.3.1).

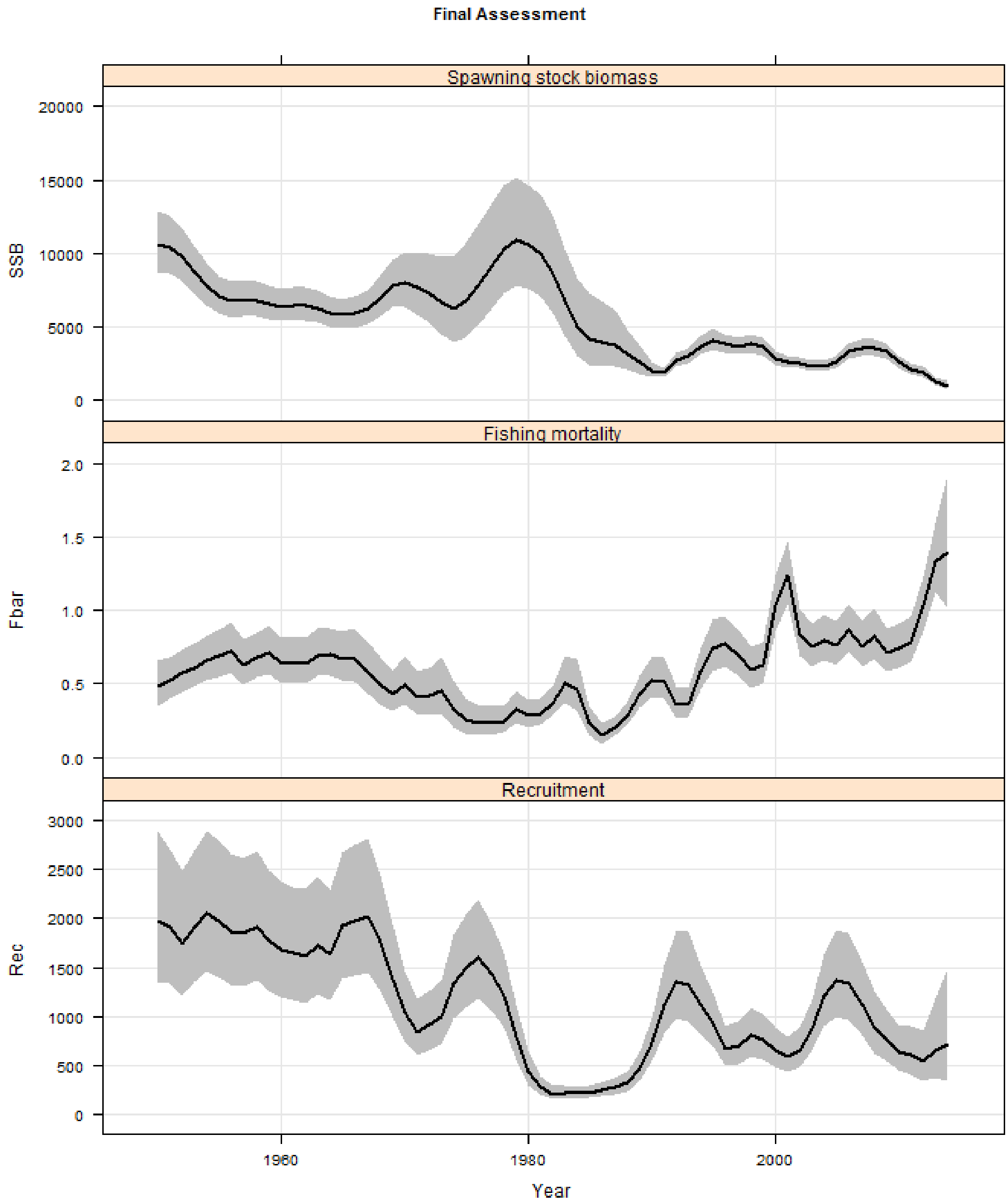


Figure 5.2.2.7.3.1. Turbot in GSA 29. SAM summary results with estimates of uncertainty. SSB and catch are in tonnes, recruitment in 1000s individuals.

5.2.2.8 Reference points

5.2.2.8.1 Methods

The estimated reference points (biomass and exploitation rates) were the same as derived by STECF (2013).

5.2.2.9 Data quality

The available data for turbot stock assessment in 2015 is considered good enough in order to perform a reliable assessment of the stock. Information about total landings was provided, but catch at age data derived from annual sampling of the landings was not available for the whole time series. The share of the IUU fisheries by country was not reported but it was estimated and included in the

catches. The rates of the IUU fisheries on turbot by country needs further clarification and specialized studies on the issues at country level.
The available survey indices are limited only to the EU countries and there is no fishery independent information about the status of the turbot population for the rest of the coastal states. No information were provided by countries regarding the turbot discards and by-catch depending on the type of the fishing gear.

5.2.2.10 Short term predictions 2015-2017

5.2.2.10.1 Method

Short term prediction of stock size and catch was conducted based on SAM results.

5.2.2.10.2 Input parameters

The input parameters are presented on the Table 5.2.2.10.2.1. and Fig. 5.2.2.10.2.1.

Table 5.2.2.10.2.1. Turbot in GSA 29. Input to short term prediction.

Catch Numbers							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	128.96	83.86	9.31	294.67	58.22	135.85	229.96
3	139.24	224.05	29.86	92.42	94.85	57.52	177.42
4	312.07	251.30	103.77	83.08	156.77	207.85	156.88
5	197.27	162.74	183.66	107.53	131.29	212.49	101.80
6	132.29	93.99	153.73	46.09	46.14	85.40	67.60
7	69.43	117.22	86.31	56.06	71.55	37.77	35.21
8	24.00	19.22	40.26	63.96	43.98	18.23	7.58
9	3.99	2.76	13.49	28.78	21.68	10.58	0.86
10+	1.52	0.03	3.32	8.61	5.68	1.11	0.03
Catch Weights							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0.57	0.66	0.68	0.60	0.59	0.45	0.34
3	1.36	1.16	1.19	1.13	1.39	1.23	0.87
4	1.79	1.75	1.73	1.66	1.96	1.59	1.60
5	2.42	2.42	2.51	2.36	2.64	2.26	2.36
6	3.00	3.42	2.62	3.19	3.36	3.09	3.10
7	4.02	4.20	3.85	3.71	4.27	3.93	3.77
8	4.69	5.19	5.18	4.96	5.65	4.66	4.44
9	5.70	6.32	6.00	5.63	6.55	5.95	7.11
10+	6.64	7.11	7.58	7.00	6.89	7.00	7.75
Fishing mortality							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0.17	0.10	0.04	0.31	0.27	0.22	0.32
3	0.17	0.18	0.17	0.19	0.21	0.23	0.23
4	0.36	0.37	0.36	0.33	0.38	0.48	0.55
5	0.50	0.56	0.63	0.67	0.61	0.74	0.82
6	0.49	0.53	0.63	0.54	0.67	0.72	0.79
7	0.99	0.98	0.90	0.85	1.32	1.34	1.05

8	1.80	1.12	1.19	1.55	2.16	3.42	3.80
9	1.80	1.12	1.19	1.55	2.16	3.42	3.80
10+	1.80	1.12	1.19	1.55	2.16	3.42	3.80
Natural mortality							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0.146	0.146	0.146	0.146	0.146	0.146	0.146
3	0.139	0.139	0.139	0.139	0.139	0.139	0.139
4	0.136	0.136	0.136	0.136	0.136	0.136	0.136
5	0.134	0.134	0.134	0.134	0.134	0.134	0.134
6	0.133	0.133	0.133	0.133	0.133	0.133	0.133
7	0.132	0.132	0.132	0.132	0.132	0.132	0.132
8	0.131	0.131	0.131	0.131	0.131	0.131	0.131
9	0.130	0.130	0.130	0.130	0.130	0.130	0.130
10	0.130	0.130	0.130	0.130	0.130	0.130	0.130
Maturity							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0	0	0	0	0	0	0
3	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	0.68	0.68	0.68	0.68	0.68	0.68	0.68
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1
Stock Numbers							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	888.6	767.5	639.1	610.7	543.2	660.7	716.2
3	860.5	644.0	599.9	534.1	386.8	356.4	460.6
4	805.6	631.0	462.2	444.7	388.0	274.2	246.3
5	551.9	490.0	381.0	279.3	283.3	231.6	148.4
6	324.6	290.8	243.8	176.7	124.1	135.4	97.6
7	113.2	177.1	149.3	113.4	90.5	55.4	58.2
8	25.3	36.9	58.5	53.5	42.6	21.2	12.6
9	2.8	3.7	10.6	15.8	10.0	4.3	0.6
10+	1.1	0.6	1.2	3.2	3.5	1.4	0.2
Stock Weights							
age/year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	0.57	0.66	0.68	0.60	0.59	0.45	0.34
3	1.36	1.16	1.19	1.13	1.39	1.23	0.87
4	1.79	1.75	1.73	1.66	1.96	1.59	1.60
5	2.42	2.42	2.51	2.36	2.64	2.26	2.36
6	3.00	3.42	2.62	3.19	3.36	3.09	3.10
7	4.02	4.20	3.85	3.71	4.27	3.93	3.77
8	4.69	5.19	5.18	4.96	5.65	4.66	4.44
9	5.70	6.32	6.00	5.63	6.55	5.95	7.11

10+	6.64	7.11	7.58	7.00	6.09	7.00	7.75

Short term forecast in different F scenarios computed for Black Sea turbot. Basis: F (2015) = average F (2012-2014) = 1.26; R (2015) = GM (2012–2014) = 640 (thousands); SSB (2015) = 995 t; Catch (2015) = 775 t.

5.2.2.10.3 Results

Table 5.2.2.10.3.1. Turbot in GSA 29. Short term prediction.

F scenario	Fmult	Catch 2016	Catch 2017	SSB 2015	SSB 2016	SSB 2017	Change SSB 2015-2017	Change in Catch 2016-2014
0.26	0.21	203	309	995	1196	1772	78.1	-81.7
0.00	0	0	0	995	1254	2098	110.9	-100.0
0.13	0.1	103	170	995	1225	1930	94.0	-90.7
0.25	0.2	196	301	995	1198	1782	79.1	-82.2
0.38	0.3	283	404	995	1171	1651	65.9	-74.4
0.50	0.4	363	486	995	1145	1533	54.1	-67.2
0.63	0.5	437	552	995	1120	1427	43.4	-60.5
0.75	0.6	507	606	995	1096	1331	33.8	-54.2
0.88	0.7	572	650	995	1073	1243	25.0	-48.3
1.01	0.8	633	686	995	1050	1163	16.9	-42.8
1.13	0.9	690	715	995	1028	1089	9.5	-37.6
1.26	1	744	738	995	1007	1021	2.7	-32.7
1.38	1.1	795	756	995	986	959	-3.6	-28.1
1.51	1.2	844	770	995	966	901	-9.4	-23.7
1.63	1.3	890	780	995	947	847	-14.8	-19.6
1.76	1.4	933	788	995	928	798	-19.8	-15.7
1.88	1.5	974	793	995	910	751	-24.5	-12.0
2.01	1.6	1013	795	995	892	708	-28.8	-8.4
2.14	1.7	1051	796	995	874	668	-32.8	-5.1
2.26	1.8	1086	795	995	857	631	-36.6	-1.9
2.39	1.9	1120	792	995	841	596	-40.1	1.2
2.51	2	1152	789	995	825	564	-43.3	4.1

Fishing at the F_{stq} generates a decrease of the catch of 33 % from 2014 to 2016 and an increase of the spawning stock biomass of 3% from 2015 to 2017.

Fishing at F_{MSY} (0.26) generates a decrease of the catch of about 82 % from 2014 to 2016 and an increase of the spawning stock biomass of 78 % in the 2015 - 2017.

In the case of a closed turbot fishery (zero catches) in 2016, the SSB increases about 111 % in 2016.

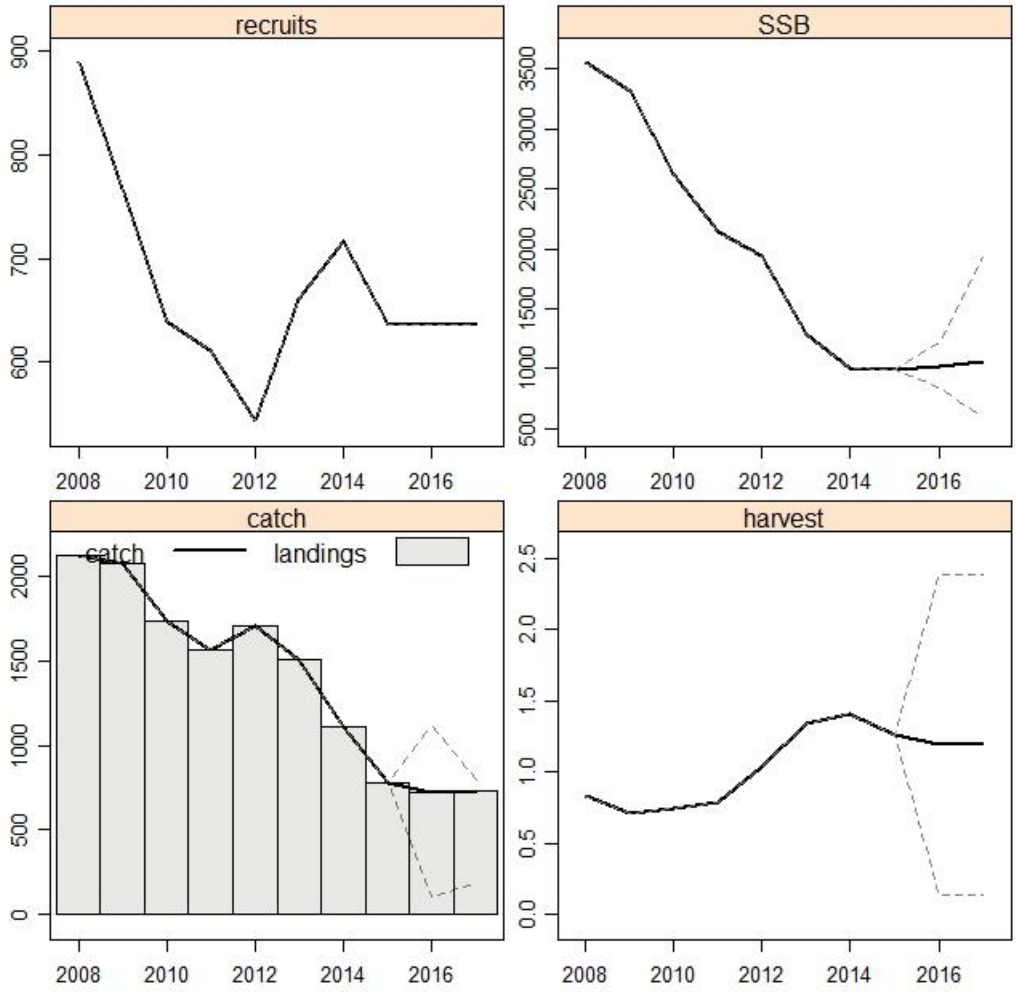


Figure 5.2.2.10.3.1. Turbot in GSA 29. Short term predictions.

5.2.2.11 Medium term predictions

5.2.2.11.1 Method

Not conducted.

5.2.2.12 Stock advice

State of the spawning stock size: The assessment indicates that the spawning stock biomass continues to be at very low level (around 1010 t) and it is estimated to be around 3.5 times lower than B_{lim} (3535 t). F in 2014 (1.40) is more than five times higher than F_{msy} (0.26).

EWG 15-12 considers that on the basis of precautionary considerations there should be no directed fisheries for turbot in GSA 29 and all bycatches mortality should be minimised in 2016. This corresponds to a 0 TAC in 2016 for this species.

5.2.3 STOCK ASSESSMENT OF RED MULLET

5.2.3.1 Stock Identification

In the vicinity of the Crimean and Caucasian coasts, two particular forms of red mullet are distinguished: “settled” and “migratory” ones. “Migratory” red mullet moves to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and and return to the coasts of the Crimea for wintering. Along coasts of Romania and Bulgaria in September-November red mullet migrates to the Turkish waters of the Black Sea and Sea of Marmara for wintering. The “migratory” form of red mullet is considered as a different stock and excluded from the current analysis. Subsequently the catches by Ukraine, which are dominated by the “migratory” form of red mullet, are excluded from this assessment.

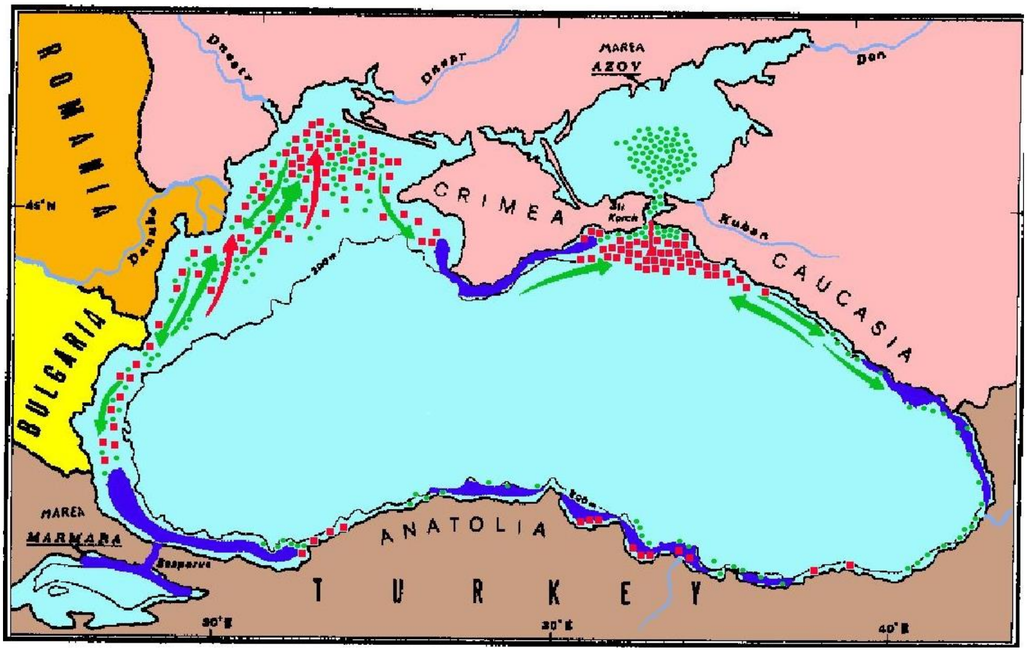


Figure 5.2.3.1. Migration routes, spawning, feeding and wintering areas of red mullet in GSA 29.

5.2.3.2 Growth

Sex ratio of the whole population is around 1:1, however, the ratio seems to vary between age and size groups. Males are dominant during the early ages, but after age of 3 and size of 14.5 cm, ratio change in favour of females. Maximum age is 9 years for females and 8 years for males. Fish of 0+, 1+ and 2+ age groups comprise approximately 80% of the population. Genç (2000) and Süer (2008) determined that the sex ratio (M:F) was 1.55:1, 1.65:1 and 1.86:1 for 2004-2006 respectively.

The longevity of red mullet was identified to six years with dominant age classes of age 2 (46.2%) and 1 (24.8%). Zengin et al. (2012) estimated a sex ratio of 0.77:1 in 2010-2012. Gumus et al. (2013) recorded that the M:F ratio of the population was 0.54:1 in 2013. The length range was between 5.2 cm and 19.2 cm at age range of 0-5 years. The average length and weight were 11.16 cm and 15.77 g, respectively. The most dominant age group was 1 year old, followed by the 2 years old. The growth parameters and regression coefficients for L-W relationship are presented in Table 5.2.3.2.1.

Table 5.2.3.2.1. Red mullet in GSA 29. Parameters of VBGF and L-W relationship.

COUNTRY	YEAR- PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b	Reference
Ukraine	1988-1990	MUT	C	17.97*	0.316	-1.876	0.0085	3.338	Domashenko (1990)
Turkey	1991-1996	MUT	F	25.55	0.238	-1.324	0.0064	3.177	Genç (2000)
	1991-1996	MUT	M	23.83	0.227	-1.624	0.0074	3.114	Genç (2000)
Turkey	2004-2006	MUT	M	25.25	0.154	-1.590	0.0700	3.170	Süer (2008)
Turkey	2004-2006	MUT	F	39.36	0.082	-1.920	0.0700	3.140	Süer (2008)
Turkey	2004-2005	MUT	C	20.15	0.330		0.0107	2.972	Aksu et al, 2011
Turkey	2010	MUT	C	18.97	0.486	-0.961	0.0070	3.150	Zengin et al.(2012)
Turkey	2011	MUT	C	20.66	0.442	-1.327	0.0070	3.150	Zengin et al.(2012)
Turkey	2012	MUT	C	21.37	0.409	-1.479	0.0060	3.210	Zengin et al.(2012)
Turkey	2013	MUT	C	21.97	0.287	-1.086	0.0080	3.110	Gumus et al (2013)
Romania	2013	MUT	C	12.63	0.411	-2.273	0.0050	3.270	NDCP, 2013
Turkey	2014	MUT	C	21.71	0.403	-1.834	0.0080	3.150	

* - standard length (SL)

5.2.3.3 Maturity

In eastern Black Sea Genç (2000) reported that the first sexual maturity is attained at 10.17 cm in males and 11.28 cm in females. In general, fish of these sizes are one year old. Red mullets in this region spawn from end of May up to beginning of August. Spawning take place in surface layers of above 20 m at 18-25°C, salinity of 17-18‰ and dissolved oxygen concentrations of 6-9 mg/L. Mean size of ovulated egg ready for release has been measured as 756±2.21 (545-1050) µ and average relative fecundity is 149.7±8.97 eggs/g.

In Ukraine, the migratory form of red mullet matures at ages of 1+ (the main part recruitments of the spawning stock) or 2+ (Sirotenko and Danilevsky, 1979). In the Azov Sea red mullet does not spawn.

5.2.3.4 Natural mortality

Table 5.2.3.4.1 reports the data from various studies regarding mortality and exploitation rates of red mullet. According to various authors in the period 1991-1996 natural mortality rate (M) varied between 0.36 and 0.44. Selectivity values (L_{50}) have been calculated as 12.57, 13.19 and 13.77 cm for trawl with cod-end mesh sizes of 18, 20 and 22 mm, respectively (Genç, 2000). Aksu et al. (2011) reported some population parameters of red mullet from southern-mid Black Sea for 2004-2005 as $W=0.0107L^{2.9717}$, L_{inf} =20.15, K=0.33, M=0.68 and F=0.60. The natural mortality was estimated as 0.581 and 1.087 from Turkish and Romanian samplings in 2013, respectively (Gumus et al., 2013; NDCP, 2013) and as 0.728 and 0.817 for Turkish and Romanian samplings in 2014, respectively.

Table 5.2.3.4.1. Red mullet in GSA 29. Mortality and exploitation rates.

	Mortality	Exploitation rate	Sampling year

	Total mortality (Z)	Natural mortality (M)	Fishing mortality (F)	(E)	
Bingel *et al.* (1996)	6.17	0.92	5.25	0.80	1991
	5.97	0.91	5.06	0.80	1992
Genç (2000)	1.41	0.36	1.05	0.74	1991
	1.42	0.43	0.99	0.70	1992
	1.51	0.43	1.08	0.72	1993
	1.16	0.44	0.72	0.62	1994
	1.41	0.41	1.00	0.71	1995
	1.36	0.39	0.97	0.71	1996
	1.41	0.39	1.02	0.72	1991-96
Genç *et al.* (2002)	2.30	0.37	1.93	0.84	2000
Aksu *et al.* (2011)	1.28	0.68	0.60	0.47	2004-2005
Zengin *et al.* (2012)	1.46	0.66	0.80	0.55	2010-2012

In Ukrainian waters there are differences in the growth between settled and migratory forms of red mullet. The migratory form has a higher growth rate. The parameters of VBGF, the length-weight relationships and natural mortality M were estimated by Domashenko (1990); Migratory form: $K= 0.316$ $t_0= -1.876$; $SL_\infty= 17.97$ cm; $W_\infty= 100.5$ g; $W= 0.0085 \times L^{3.338}$; $M = 0.8$.

5.2.3.5 Fisheries

5.2.3.5.1 General description of the fisheries

Red mullet is one of the most important fish species fished and consumed traditionally in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second species after whiting composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). Gillnets are also allowed to fish red mullet all along Turkish coasts and through all seasons but only 10% of the total landing is obtained by this gear. Catches of red mullet in EU waters are taken primarily by Bulgaria (314 t during 2014, 28.3% of the Black Sea total), with only small amounts landed by Romanian fishers (9 t during 2014, about 0.8% of the Black Sea total). In the waters of Georgia according to the data of official statistics in 1989 – 1996 catches of red mullet were absent or was categorized within the “other fish” group. In 1997 – 2005, its mean annual catch was equal to 28 tons. According to Komakhidze *et al.* (2003), the red mullet was captured recently in higher amounts that provided an indirect evidence of increasing abundance. Along the coasts of the Russian Federation target fisheries of red mullet are performed mainly with passive fishing gears. The catches exceeded 100 tons by 1998 which was mainly related to the reduction of *Mnemiopsis leidyi* population (Volovik and Agapov, 2003). In 2002, the total biomass was estimated at 1200 tons, exploited biomass at 960 tons and TAC at 200 tons. In Ukrainian waters, target fishing of the red mullet was permitted only with beach seines and bottom set traps; however, the greater part of its catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested in autumn in Balaklava Bay, near Sebastopol.

5.2.3.5.2 Management regulations applicable in 2015

In Turkey the red mullet fishery is regulated by area and season closures of the fisheries:

(1) Area closures: Bottom trawling is prohibited in waters between a) Sinop city. İnceburun (42° 05.959’ N-34° 56.695’ E) and Samsun city Çayağzı cape (41° 41.040’ N-35° 25.193’ E), b) Ordu city; Ünye. Taşkana cape (41° 08.725’ N-37° 17.531’ E) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli. Baba cape (41° 17.342’ N-31° 23.937’ E) and Bartın city; Amasra. Tekke cape (41° 43.485' N-32° 19.258' E). In other areas open to trawling the allowed distance is 3 miles.

(2) Time closures: In open areas, red mullet fishery with bottom trawling is banned between April 15 and September 15. Gillnets were allowed all along the Turkish coasts for red mullet fishery except April 15-June 15.
(3) Mesh size limitations: Cod end mesh size should not be lower than 40 mm in bottom trawl nets.
(4) Minimum legal catch size: Minimum legal size (total length) was determined as 13 cm for all kind of fishing gears.

In Ukraine fisheries regulations set the minimum commercial fishing size for red mullet as 8.5 cm (SL); the allowable by-catch of juveniles in non-target fishery to be no more than 8% of the total weight of a haul and in target fishery – no more than 20% of the catch. The mesh size in beach seines and in scrapers should not be less than 10 mm. Bottom-trawling is prohibited in Bulgaria. Closed season for all coastal fisheries is between 15 April to 15 June. Minimum landing sizes of red mullet in the Black sea region are present in Table 5.2.3.5.2.1.

Table 5.2.3.5.2.1. Red mullet in GSA 29. Minimum landing size.

	BG	GE	RO	RU	TR	UKR
Mullus barbatus	TL=12cm	SL=8.5cm	no	SL= 8.5 cm	TL=13.0	SL=8.5cm

5.2.3.5.3 Catches (by fleet if posible)
No information has been presented.

5.2.3.5.4 Landings
An important issue was raised by a Turkish expert on possible misclassification of two Mullid species in the Black Sea; namely Red mullet (*Mullus barbatus*) and Striped red mullet (*Mullus surmuletus*). One of the reasons behind misclassification is the misuse of the local names given to the species in Turkey: *M. barbatus* is generally called "barbun", and *M. surmuletus* is called "tekir", however in some places, small sized *M. barbatus* is also called “tekir” (for reasons of its smaller size that fisher consider as a characteristic of *M. barbatus)*. Moreover, a different minimum individual size regulation is applied to the two species; according in Black Sea EU waters there is no size limit for the *M. surmuletus*, and in Turkey the minimum legal landing size of *M. barbatus* (13 cm) is larger than the one for *M. surmuletus* (11 cm). Given that the two species have very identical morphological features, it was evidenced that undersized *M. barbatus* is intentionally reported as *M. surmuletus*. This issue has been discussed in depth and based on various research carried out in the Turkish coast of the Black Sea (Keskin, 2012; Gümüş and Zengin, pers.com.), in which no *M. surmuletus* has never been reported, it was concluded that there is only one Mullid species in the Black Sea, which is abundant enough to be exploited at commercial scale, and this is Red mullet (*M. barbatus*). Nevertheless, the EWG noted the exception of the local population confined to the area around

Istanbul (Strait of Boasphorus), where the majority of the Mullids landed by gillnet fishery is composed of *M. surmuletus* (Karakulak, pers. com). Therefore for the assessment, the landings data of *M. surmuletus* and *M. barbatus* were merged and further treated as *M. barbatus* (Red mullet) only, and the exception noted above is considered as minor and not affecting the outputs of the analysis.

In Table 5.2.3.5.4.1 are presented the landings of the red mullet and striped red mullet reported by the Black Sea countries. Trends in red mullet landings differ between countries (Figure 5.2.3.5.4.1). Reported red mullet landings of Turkey (Figure 5.2.3.5.4.1B) have significantly decreased in the last 15 years, whereas landing of the rest of the countries have increased (Figure 5.2.3.5.4.1A). In contrast, reported striped red mullet landings of Turkey (Figure 5.2.3.5.4.1B) have increase in parallel with the red mullet landings of the other countries (increase started in 2007-2008).

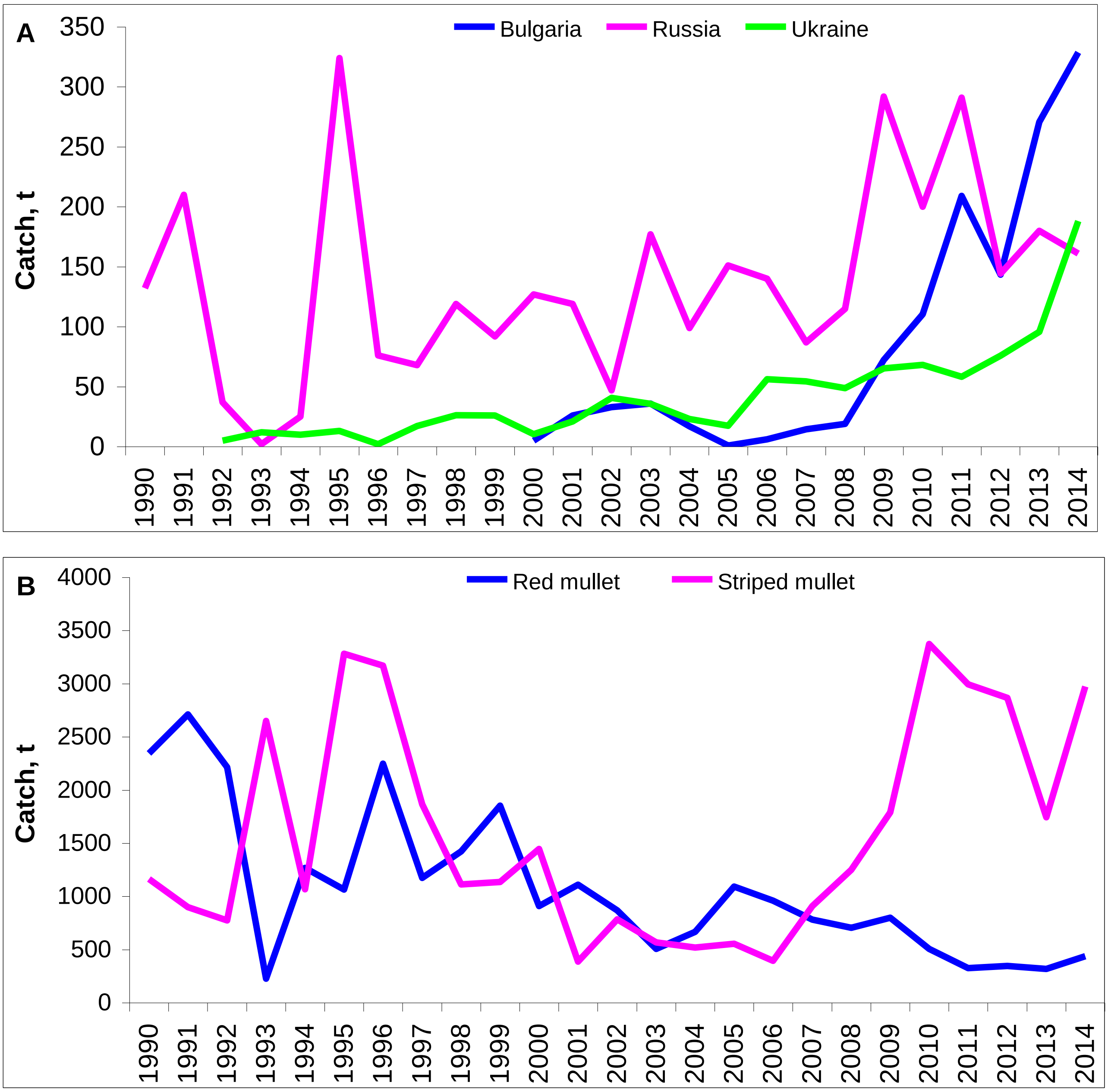


Figure 5.2.3.5.4.1. Catches of Red mullet in Bulgaria, Russia, and Ukraine. **B:** Catches of Red mullet and Striped red mullet in Turkey. Note the divergent trends after 2003.

Table 5.2.3.5.4.1. Red mullet and Striped mulled landings (tons) in the Black Sea.

Years	Bulgaria Red mullet	Bulgaria Striped mullet	Georgia	Romania	Russian Federation	Turkey Red mullet	Turkey Striped mullet	Ukraine
1988					129			
1989					324			
1990					132	2344	1163	
1991					210	2712	898	
1992					37	2214	774	5
1993					2	227	2650	12
1994					25	1269	1068	10
1995					324	1065	3283	13
1996					76	2249	3170	2
1997					68	1173	1867	17
1998					119	1423	1113	26
1999					92	1853	1136	26
2000	5				127	910	1445	10
2001	26				119	1110	388	21
2002	33				47	867	784	41
2003	36				177	506	567	36
2004	17				99	668	519	23
2005	1				151	1093	556	17
2006	6				140	960	395	56
2007	13	2			87	781	910	54
2008	17	2			115	706	1251	49
2009	48	24			292	799	1790	65
2010	72	38			200	507	3373	68
2011	176	33	22	2	291	326	2994	58
2012	131	12			144	347	2868	76
2013	256	15		3	180	318	1743	96
2014	314	15		9	161	438	2973	188

5.2.3.5.5 Discards
Discards are reported only by Romania and added to their reported landing in Table 5.2.3.5.4.1.

5.2.3.5.6 Fishing effort (by fleet if possible)
No information has been presented.

5.2.3.6 Scientific surveys

5.2.3.6.1 Survey #1 Turkish trawl survey

5.2.3.6.1.1 Methods

The survey period includes 7 months (from January to April and from September). Abundance indices were estimated by 'swept area method' from commercial vessels (Sparre and Venema, 1992).

5.2.3.6.1.2 Geographical distribution

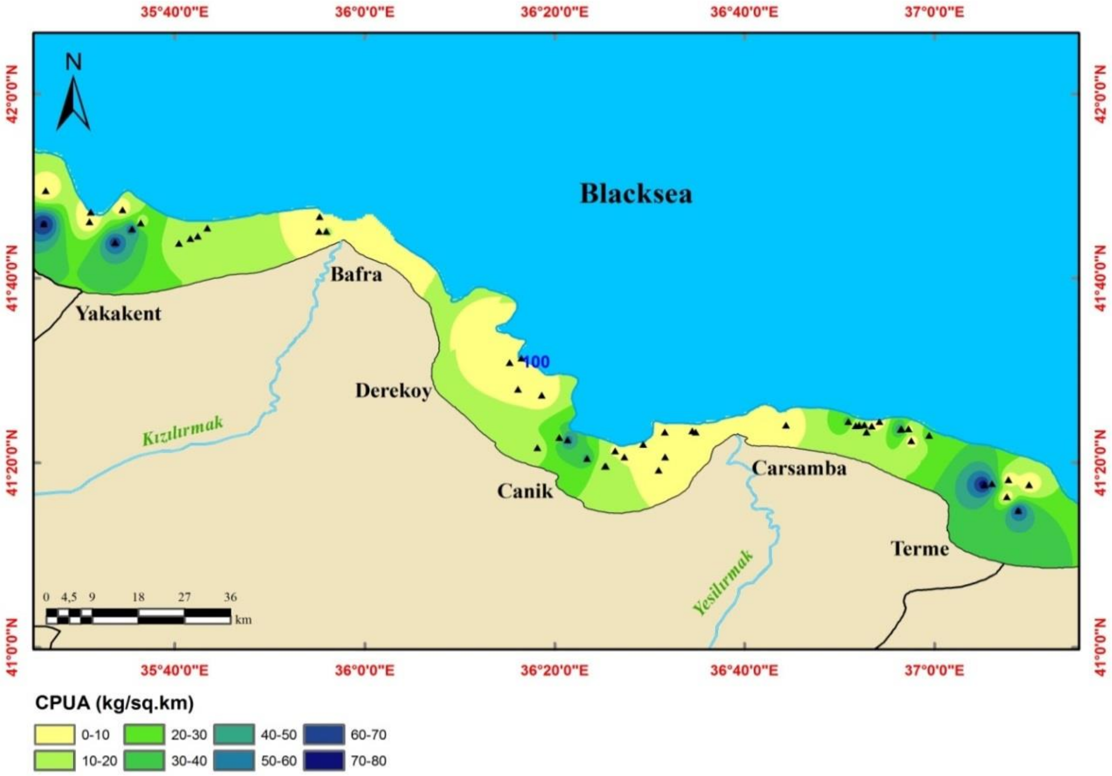
Trawl samplings conducted is generally below of 40 m (minimum 24.7 m, maximum 113.0 m) depths along in the SSA (Samsun Shelf Area) and WBS (West Black Sea) littorals zones.

5.2.3.6.1.3 Trends in abundance and biomass

The mean catches per unit effort (CPUE) and abundance index (CPUA) are present in Table 5.2.3.6.1.3.1. The stock is localized under the layer of 30-50 m generally. Biomass indices of pooled data by mapping two parts of Turkish Black Sea are given in Figure 5.2.3.6.1.3.1.

Table 5.2.3.6.1.3.1. Descriptive data regarding CPUE (kg/h) and abundance indices CPUA (kg/km^2) of red mullet for 2012 and 2013 in the Samsun shelf area (SSA) and West Black Sea.

	Region	Number of hauls	Minimum	Maximum	Mean	Std.E.of mean	Std. Dev.
2012	CPUE/SSA	60	0.0	37.9	7.7	1.3	10.1
	CPUE/ WBS	44	0.0	53.3	7.8	1.8	12.2
	CPUA/ SSA	60	0.0	80.0	16.0	2.8	21.9
	CPUA/WBS	44	0.0	125.0	17.4	4.3	28.7
2013	CPUE/SSA	42	0.0	40.0	12.9	2.1	13.7
	CPUE/ WBS	65	0.0	55.0	5.9	1.1	8.8
	CPUA/ SSA	42	0.0	300.0	78.7	13.9	90.3
	CPUA/WBS	65	0.0	265.0	33.7	6.0	48.2



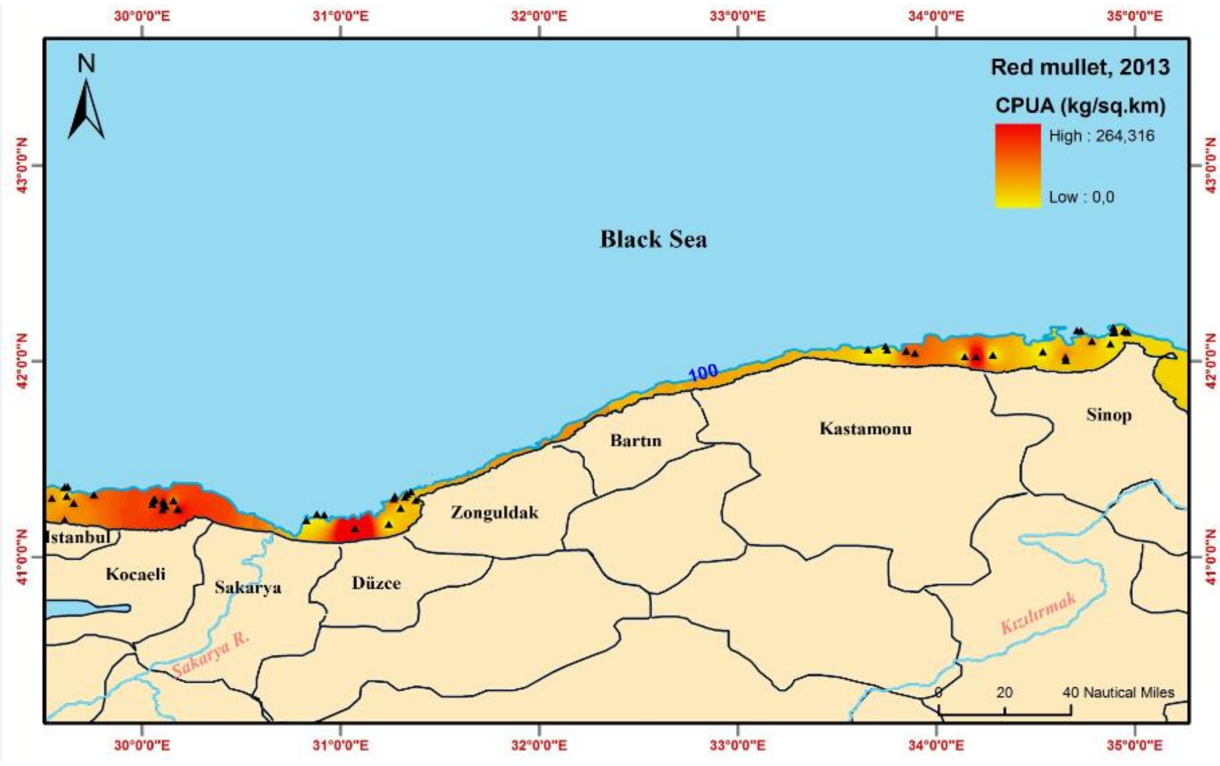


Figure 5.2.3.6.1.3.1. Red mullet in GSA 29. Map of biomass indices in the Samsun Shelf Area (upper) and West Black Sea (lower) for 2013

5.2.3.6.1.4 Trends in abundance by length or age

None

5.2.3.7 Stock Assessment

5.2.3.7.1 Methods

XSA was used to perform a quantitative assessment of red mullet in GSA 29. The available data for the period 1990 to 2014 in terms of catch at ages 0 - 6+, weights at age, maturity and natural mortality were used for the application of the XSA. Turkish bottom-trawl survey data were used for tuning

5.2.3.7.2 Input data

Input data are presented in Table 5.2.3.7.2. Catch at age matrix was constructed based on landing data from all Black Sea countries except Ukraine. As mentioned in the section of Stock Identification (5.2.3.1.), the fisheries in Ukraine are considered to exploit a different stock than other Black Sea countries. Age composition from the Turkish fisheries (which is accounting for the majority of the catches) was applied to all catches, except the catch of Romania, for which catch-at-age is available. Age structured data (2009-2014 ages 1-5) from the Turkish Bottom Trawl Survey ware used as a tuning index.

Table 5.2.3.7.2.1. Red mullet in GSA 29. Input data for XSA.

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    year
age   2007   2008   2009   2010   2011   2012   2013   2014
  all 1884.5 1796.5 2623.9 3947.7 3522.8 3487.9 2495.3 3898.7

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  1  31872  30111  37048  19447  23911  41973  39611  25109  41170  82839  66868  36927  26601  19763  19846  27965  23067
  2  32812  40578  31289  25245  22052  36612  41557  23922  29058  49052  39595  22989  23296  17307  14057  29869  20200
  3  23801  27322  21430  19942  15321  27159  32392  18197  13839  13029  10517   7574  18068  13423  12128  21182  15667
  4  20497  18654  13128  17537  12949  28993  35719  19754  11369   3403   2747   3838   2015   1497   1194   2618   1747
  5   2013   1530    986   1131   1026   4021   4708   2669   1528    438    353    510    514    382    643    119    445
  6    597    540    311    636    385    635   1130    533    292     49     39     86    566    421    643    238    491
   year
age 2007   2008   2009   2010   2011   2012   2013   2014
  0   3205  12238  36183  34662  68937  44938  12087 116930
  1  27653  55358 126225 172745 185806 174263 104992 238510
  2  26781  34879  52895  84798  64769  58723  49458  60437
  3  19825  18158  10793  19900  10475  15619  13785  17610
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  1 0.0128 0.0088 0.0088 0.0088 0.0088 0.0088 0.0094 0.0077
  2 0.0231 0.0178 0.0178 0.0183 0.0179 0.0173 0.0174 0.0167
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  4 0.0576 0.0392 0.0392 0.0376 0.0390 0.0409 0.0392 0.0407
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  6 0.44

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  2 0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8
  3 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  6 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
   year
age 2014
  0 0.0
```

```
 1 0.6
 2 0.8
 3 1.0
 4 1.0
 5 1.0
 6 1.0

Slot "range":
     min      max plusgroup   minyear   maxyear   minfbar   maxfbar
       0        6         6      1990      2014         2         5

Slot "index":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009  2010  2011  2012  2013  2014
  1 672.0 531.0 718.0 387.0 363.0 533.0
  2 282.0 261.0 250.0 130.0 171.0 135.0
  3  58.0  61.0  40.0  35.0  47.0  39.0
  4  13.0  13.0  11.0  16.0  19.0   7.0
  5   3.0   1.0   4.0   1.0   1.0   0.4
```

5.2.3.7.3 Results

Parameters and options in applying XSA on the red mullet are shown below:

FLXSA.control.mul2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2,
rage=0, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5,shk.ages=3,window=100, tsrange=20, tspower=3, vpa=FALSE)

Final estimates were made with applying shrinkage to the mean F of the final 5 years. Retrospective analyses (Fig. 5.2.3.7.3.1) did not show any particular pattern. Residuals between observed and estimated log catchabilities of the tuning index are relatively small and no systematic patterns are detected (Fig. 5.2.3.7.3.2).

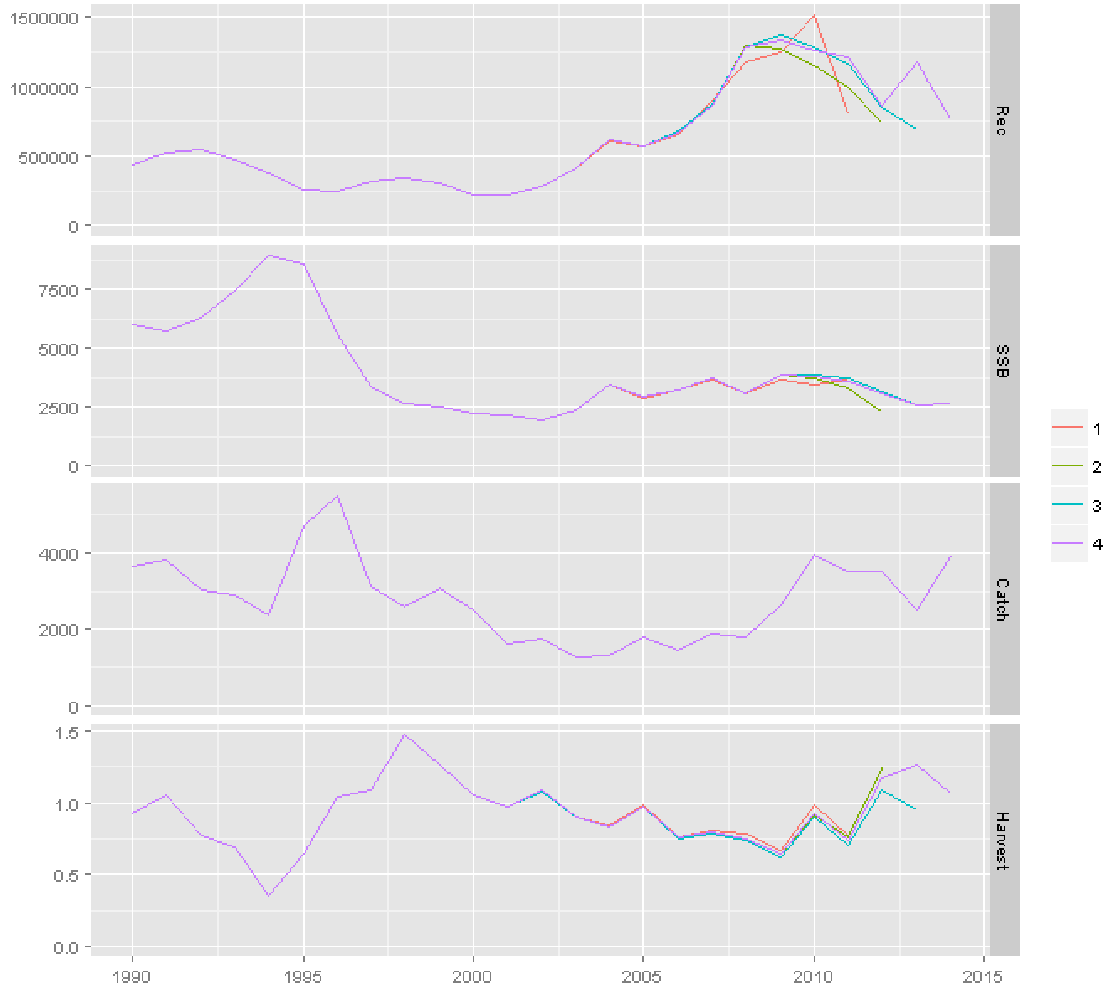

Fig. 5.2.3.7.3.1. Red mullet in GSA 29. Retrospective analyses.

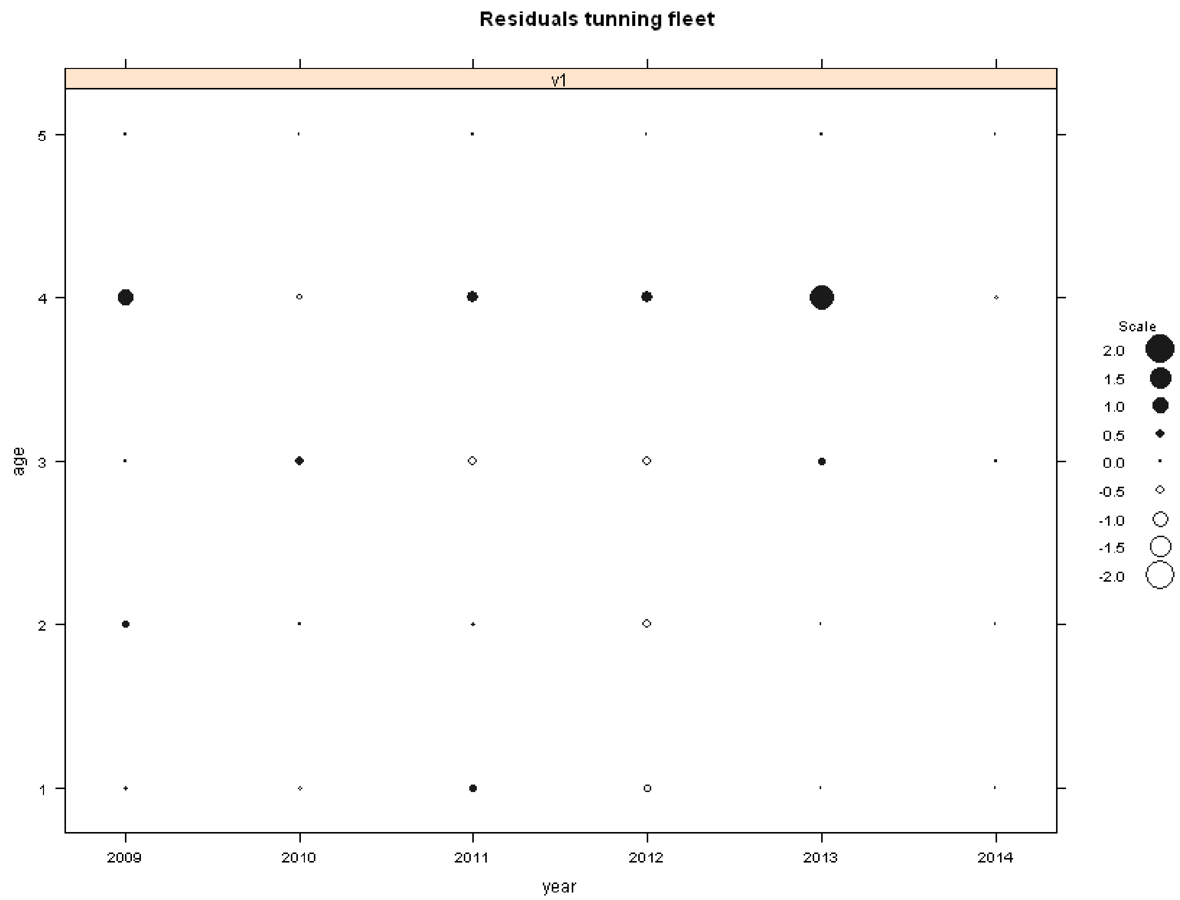

Fig. 5.2.3.7.3.2. Red mullet in GSA 29. Residuals between observed and estimated log catchabilities of the tuning index.

Table 5.2.3.7.3.1. Red mullet in GSA 29. Diagnostics of the XSA.

```
An object of class "FLXSA"
Slot "survivors":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990       1991       1992       1993       1994       1995       1996       1997       1998       1999       2000
  0 4.4491e+05 5.2756e+05 5.4621e+05 4.7804e+05 3.8519e+05 2.5955e+05 2.4671e+05 3.2373e+05 3.4289e+05 3.1026e+05 2.1914e+05
  1 2.8909e+05 2.7881e+05 3.2834e+05 3.4391e+05 3.0430e+05 2.4478e+05 1.5697e+05 1.4534e+05 2.0126e+05 2.1659e+05 1.9834e+05
  2 1.4365e+05 1.6061e+05 1.5540e+05 1.8173e+05 2.0588e+05 1.7679e+05 1.2396e+05 6.9307e+04 7.3452e+04 9.6579e+04 7.3012e+04
  3 7.1155e+04 6.6187e+04 7.0873e+04 7.4972e+04 9.6780e+04 1.1490e+05 8.4479e+04 4.6487e+04 2.5438e+04 2.3986e+04 2.2836e+04
  4 3.0033e+04 2.6726e+04 2.0700e+04 2.8447e+04 3.2281e+04 5.0035e+04 5.2203e+04 2.8412e+04 1.5336e+04 5.2772e+03 4.9920e+03
  5 4.0910e+03 2.8932e+03 2.2421e+03 2.7962e+03 4.2468e+03 1.0398e+04 8.9566e+03 4.9553e+03 2.4456e+03 7.5295e+02 6.6774e+02
  6 1.1635e+03 1.0193e+03 6.3546e+02 6.5272e+02 8.9319e+02 1.9117e+03 3.4701e+03 1.9901e+03 1.0495e+03 3.4880e+02 1.3342e+02
   year
age 2001       2002       2003       2004       2005       2006       2007       2008       2009       2010       2011
  0 2.1950e+05 2.8891e+05 4.1355e+05 6.1590e+05 5.7563e+05 6.7455e+05 8.6851e+05 1.2846e+06 1.3325e+06 1.2584e+06 1.2144e+06
  1 1.3994e+05 1.3986e+05 1.8307e+05 2.6412e+05 2.9426e+05 2.7567e+05 3.2282e+05 4.1632e+05 6.1058e+05 6.1701e+05 5.8238e+05
  2 7.4075e+04 6.0491e+04 6.8728e+04 1.0204e+05 1.1350e+05 1.2239e+05 1.1683e+05 1.3637e+05 1.6220e+05 2.0662e+05 1.7742e+05
  3 1.5247e+04 2.9258e+04 2.0263e+04 3.0374e+04 3.9417e+04 3.3963e+04 4.4959e+04 3.7712e+04 4.1507e+04 4.1445e+04 4.0706e+04
  4 6.2668e+03 3.7410e+03 4.3433e+03 2.2779e+03 6.2183e+03 4.2911e+03 5.4910e+03 7.9036e+03 5.5684e+03 1.2510e+04 6.1582e+03
  5 1.0105e+03 9.5599e+02 7.9228e+02 1.5958e+03 2.6886e+02 1.1793e+03 8.5517e+02 1.0266e+03 2.0886e+03 9.2574e+02 3.0645e+03
  6 1.4676e+02 2.4154e+02 2.0320e+02 2.0370e+02 3.2268e+02 4.6959e+01 2.5938e+02 1.8094e+02 2.2607e+02 6.6976e+02 1.6981e+02
   year
age 2012       2013       2014       2015
  0 8.6300e+05 1.1813e+06 7.6872e+05 4.0124e+05
  1 5.3735e+05 3.8469e+05 5.6089e+05 4.0124e+05
  2 1.5167e+05 1.3798e+05 1.1250e+05 1.6982e+05
  3 4.0540e+04 3.2324e+04 3.2161e+04 2.3951e+04
  4 1.2345e+04 8.6939e+03 6.0078e+03 6.5793e+03
  5 9.6977e+02 8.0847e+02 3.3481e+02 1.4941e+03
  6 7.8595e+02 1.6186e+02 1.6258e+02 7.2770e+01

units:  NA

Slot "se.int":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2015
  0 2.00000
  1 0.30038
  2 0.23346
  3 0.22138
  4 0.28967
  5 0.30118

units:  NA

Slot "se.ext":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2015
  0 0.000000
  1      Inf
  2 0.180675
  3 0.165062
  4 0.276405
  5 0.059114

units:  NA

Slot "n.fshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA

Slot "n.nshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique
```

```
    year
age   1
  all NA

units:  NA

Slot "var.fshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age   1
  all NA

units:  NA

Slot "var.nshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age   1
  all NA

units:  NA

Slot "q.hat":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1
  1 0.0016654
  2 0.0024230
  3 0.0023368
  4 0.0023368
  5 0.0023368

units:  NA


Slot "q2.hat":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1
  1 1
  2 1
  3 1
  4 1
  5 1

units:  NA


Slot "diagnostics":
          w      nhat yrcls age year source
1  0.25000000  6.926879  1985   5 1990   fshk
2  0.25000000  6.454351  1986   5 1991   fshk
3  0.25000000  6.481150  1987   5 1992   fshk
4  0.25000000  6.794803  1988   5 1993   fshk
5  0.25000000  7.555760  1989   5 1994   fshk
6  0.25000000  8.151924  1990   5 1995   fshk
7  0.25000000  7.595964  1991   5 1996   fshk
8  0.25000000  6.956057  1992   5 1997   fshk
9  0.25000000  5.854492  1993   5 1998   fshk
10 0.25000000  4.893512  1994   5 1999   fshk
11 0.25000000  4.988817  1995   5 2000   fshk
12 0.25000000  5.487042  1996   5 2001   fshk
13 0.25000000  5.314178  1997   5 2002   fshk
14 0.25000000  5.316625  1998   5 2003   fshk
15 0.25000000  5.776670  1999   5 2004   fshk
16 0.25000000  3.849267  2000   5 2005   fshk
17 0.25000000  5.558292  2001   5 2006   fshk
18 0.25000000  5.198178  2002   5 2007   fshk
19 0.25000000  5.420855  2003   5 2008   fshk
20 7.05312543  6.535654  2004   5 2009 TUR BT
```

```
21 0.25000000  5.696165  2004   5 2009   fshk
22 4.12911838  5.094008  2005   5 2010 TUR BT
23 0.21731908  5.900290  2005   4 2009 TUR BT
24 0.25000000  5.140884  2005   5 2010   fshk
25 5.85453796  6.688998  2006   5 2011 TUR BT
26 0.45820756  6.478882  2006   4 2010 TUR BT
27 1.73540666  6.693281  2006   3 2009 TUR BT
28 0.25000000  6.310653  2006   5 2011   fshk
29 3.83755080  5.033793  2007   5 2012 TUR BT
30 0.19440405  5.604003  2007   4 2011 TUR BT
31 0.36633468  5.430852  2007   3 2010 TUR BT
32 0.19614178  5.360854  2007   2 2009 TUR BT
33 0.25000000  4.778239  2007   5 2012   fshk
34 4.63558271  5.152103  2008   5 2013 TUR BT
35 0.09810297  5.572429  2008   4 2012 TUR BT
36 0.37989173  4.763013  2008   3 2011 TUR BT
37 0.15827016  5.144582  2008   2 2010 TUR BT
38 0.10859480  5.170452  2008   1 2009 TUR BT
39 0.25000000  4.203395  2008   5 2013   fshk
40 3.75038598  4.284417  2009   5 2014 TUR BT
41 0.04677689  5.440536  2009   4 2013 TUR BT
42 0.12866984  3.964701  2009   3 2012 TUR BT
43 0.06259858  4.394304  2009   2 2011 TUR BT
44 0.03683488  4.186577  2009   1 2010 TUR BT
45 0.25000000  4.268876  2009   5 2014   fshk
46 0.67047335  7.230223  2010   4 2014 TUR BT
47 1.60198793  7.561744  2010   3 2013 TUR BT
48 0.73025412  6.946245  2010   2 2012 TUR BT
49 0.39182638  7.607837  2010   1 2011 TUR BT
50 0.25000000  6.495856  2010   4 2014   fshk
51 3.41582144  8.826440  2011   3 2014 TUR BT
52 1.70670944  8.762721  2011   2 2013 TUR BT
53 0.90702044  8.557504  2011   1 2012 TUR BT
54 0.25000000  9.364176  2011   3 2014   fshk
55 3.67322081 10.056794  2012   2 2014 TUR BT
56 2.22824535 10.068286  2012   1 2013 TUR BT
57 0.25000000 10.617827  2012   2 2014   fshk
58 5.22358216 12.020064  2013   1 2014 TUR BT
59 0.25000000 12.510834  2013   1 2014   fshk
60 0.25000000 14.375627  2014   0 2014   fshk
61 4.25042314 12.815655  2014   0 2014   nshk

Slot "control":
tol                      3.646699e-07
maxit                    30
min.nse                  0.3
fse                      2
rage                     0
qage                     3
shk.n                    TRUE
shk.f                    TRUE
shk.yrs                  5
shk.ages                 3
window                   100
tsrange                  20
tspower                  3
vpa                      FALSE

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA
```

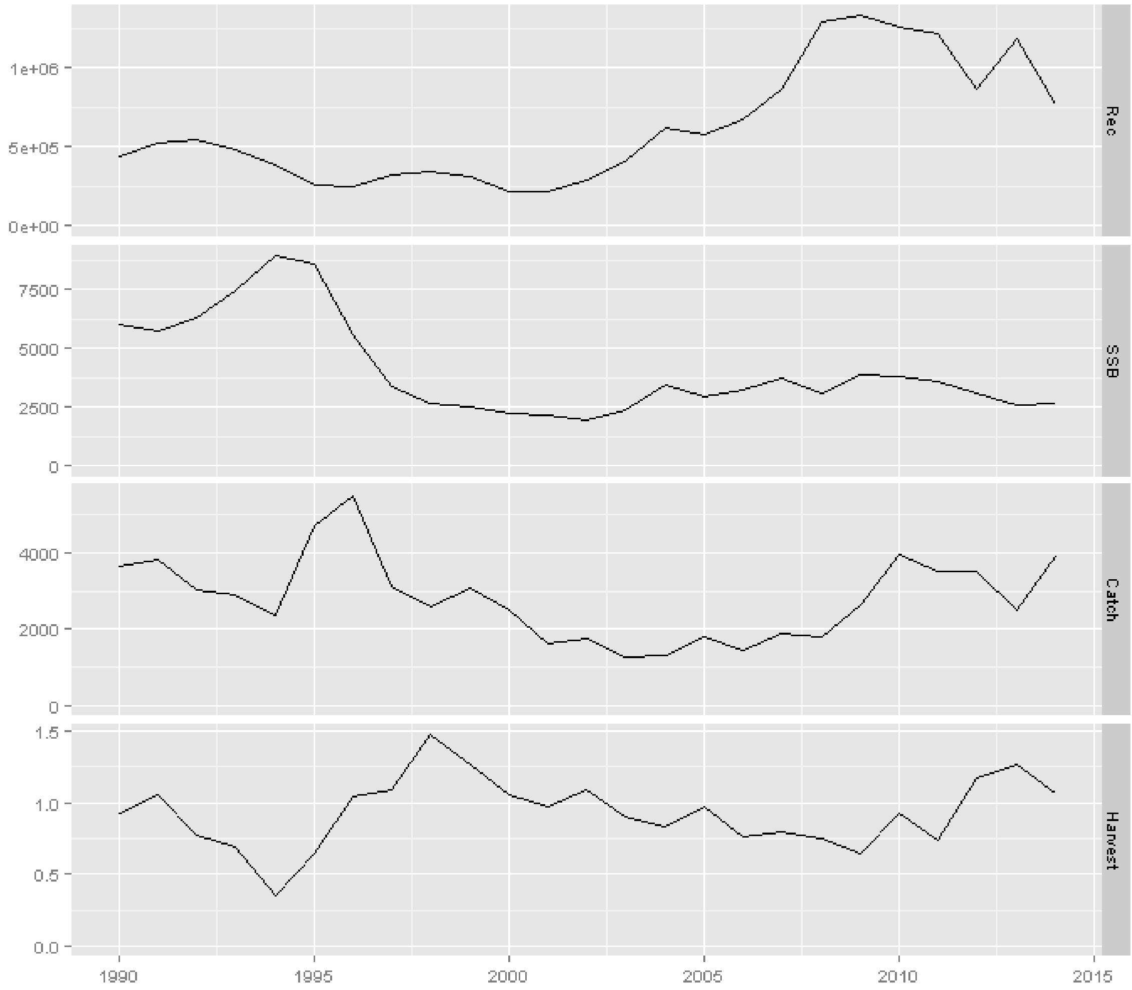

Fig. 5.2.3.7.3.3. Red mullet in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

The summary of the population estimates from the XSA is presented in Fig. 5.2.3.7.3.3. The SSB drops in the late 1990s and has some increase over 2004-2010. After 2010, SSB decreased again to 2500 t. Estimates of recruitment are rather imprecise due to the lack of survey data. Recruitment shows an increasing trend after 2000 that is reflected by the dominant amount of younger fish in the catches. Fishing mortality is consistently high: 0.8 - 1.4 except in 1993 when the catch dropped suddenly about 10 time compared to the previous years.

Detailed assessment results are presented in the Table 5.2.3.7.3.2 bellow.

Table 5.2.3.7.3.2. Red mullet in GSA 29. XSA results.

```
Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990      1991      1992      1993      1994      1995      1996      1997      1998      1999      2000
  0 4.4491e+05 5.2756e+05 5.4621e+05 4.7804e+05 3.8519e+05 2.5955e+05 2.4671e+05 3.2373e+05 3.4289e+05 3.1026e+05 2.1914e+05
  1 2.8909e+05 2.7881e+05 3.2834e+05 3.4391e+05 3.0430e+05 2.4478e+05 1.5697e+05 1.4534e+05 2.0126e+05 2.1659e+05 1.9834e+05
  2 1.4365e+05 1.6061e+05 1.5540e+05 1.8173e+05 2.0588e+05 1.7679e+05 1.2396e+05 6.9307e+04 7.3452e+04 9.6579e+04 7.3012e+04
  3 7.1155e+04 6.6187e+04 7.0873e+04 7.4972e+04 9.6780e+04 1.1490e+05 8.4479e+04 4.6487e+04 2.5438e+04 2.3986e+04 2.2836e+04
  4 3.0033e+04 2.6726e+04 2.0700e+04 2.8447e+04 3.2281e+04 5.0035e+04 5.2203e+04 2.8412e+04 1.5336e+04 5.2772e+03 4.9920e+03
  5 4.0910e+03 2.8932e+03 2.2421e+03 2.7962e+03 4.2468e+03 1.0398e+04 8.9566e+03 4.9553e+03 2.4456e+03 7.5295e+02 6.6774e+02
  6 1.1635e+03 9.7502e+02 6.8183e+02 1.5209e+03 1.5604e+03 1.5908e+03 2.0535e+03 9.4374e+02 4.3998e+02 7.9858e+01 7.0444e+01
   year
```

```
age 2001      2002      2003      2004      2005      2006      2007      2008      2009      2010      2011
  0 2.1950e+05 2.8891e+05 4.1355e+05 6.1590e+05 5.7563e+05 6.7455e+05 8.6851e+05 1.2846e+06 1.3325e+06 1.2584e+06 1.2144e+06
  1 1.3994e+05 1.3986e+05 1.8307e+05 2.6412e+05 2.9426e+05 2.7567e+05 3.2282e+05 4.1632e+05 6.1058e+05 6.1701e+05 5.8238e+05
  2 7.4075e+04 6.0491e+04 6.8728e+04 1.0204e+05 1.1350e+05 1.2239e+05 1.1683e+05 1.3637e+05 1.6220e+05 2.0662e+05 1.7742e+05
  3 1.5247e+04 2.9258e+04 2.0263e+04 3.0374e+04 3.9417e+04 3.3963e+04 4.4959e+04 3.7712e+04 4.1507e+04 4.1445e+04 4.0706e+04
  4 6.2668e+03 3.7410e+03 4.3433e+03 2.2779e+03 6.2183e+03 4.2911e+03 5.4910e+03 7.9036e+03 5.5684e+03 1.2510e+04 6.1582e+03
  5 1.0105e+03 9.5599e+02 7.9228e+02 1.5958e+03 2.6886e+02 1.1793e+03 8.5517e+02 1.0266e+03 2.0886e+03 9.2574e+02 3.0645e+03
  6 1.6318e+02 1.0041e+03 8.3823e+02 1.4834e+03 4.9577e+02 1.2153e+03 1.0004e+03 8.8706e+02 5.5910e+02 0.0000e+00 1.1550e+03
   year
age 2012      2013      2014
  0 8.6300e+05 1.1813e+06 7.6872e+05
  1 5.3735e+05 3.8469e+05 5.6089e+05
  2 1.5167e+05 1.3798e+05 1.1250e+05
  3 4.0540e+04 3.2324e+04 3.2161e+04
  4 1.2345e+04 8.6939e+03 6.0078e+03
  5 9.6977e+02 8.0847e+02 3.3481e+02
  6 0.0000e+00 0.0000e+00 0.0000e+00

units:  NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990      1991      1992      1993      1994      1995      1996      1997      1998      1999      2000      2001
  0 0.0273416 0.0342276 0.0226271 0.0116805 0.0133621 0.0628983 0.0891461 0.0352967 0.0193966 0.0074455 0.0085142 0.0106785
  1 0.1477793 0.1445338 0.1515231 0.0730681 0.1030438 0.2403750 0.3775201 0.2424237 0.2942346 0.6473840 0.5449016 0.3987093
  2 0.3349345 0.3780811 0.2888736 0.1900716 0.1432559 0.2984742 0.5408197 0.5622862 0.6791515 1.0020487 1.1262705 0.4889283
  3 0.5392363 0.7223369 0.4728573 0.4026367 0.2197281 0.3489075 0.6496800 0.6689814 1.1328629 1.1296373 0.8530489 0.9649906
  4 1.8999430 2.0382042 1.5618863 1.4618554 0.6928283 1.2803181 1.9146729 2.0125366 2.5739486 1.6272473 1.1573592 1.4402763
  5 0.9496751 1.0757615 0.7940258 0.7012065 0.3581659 0.6574874 1.0641872 1.1121608 1.5075478 1.2904810 1.0750889 0.9912009
  6 0.9496751 1.0757615 0.7940258 0.7012065 0.3581659 0.6574874 1.0641872 1.1121608 1.5075478 1.2904810 1.0750889 0.9912009
   year
age 2002      2003      2004      2005      2006      2007      2008      2009      2010      2011      2012      2013
  0 0.0162620 0.0084056 0.0086325 0.0062734 0.0069496 0.0053300 0.0138180 0.0399025 0.0404866 0.0853137 0.0779728 0.0148490
  1 0.2704950 0.1444687 0.1145609 0.1472260 0.1284451 0.1316991 0.2126319 0.3535314 0.5163430 0.6154331 0.6295310 0.4994794
  2 0.6537002 0.3765653 0.2211927 0.4765563 0.2714789 0.4007775 0.4595419 0.6344499 0.8945173 0.7462555 0.8158704 0.7263646
  3 1.4675258 1.7455464 0.8560875 1.4876581 1.0921519 1.0084303 1.1828680 0.4693272 1.1765875 0.4631412 0.8096634 0.9527588
  4 1.1121993 0.5612211 1.4067966 0.9326095 0.8830034 0.9468483 0.6008289 1.0642646 0.6766563 1.1184709 1.9958337 2.5268105
  5 1.1085686 0.9182902 0.8684864 1.0149355 0.7843462 0.8230971 0.7831290 0.4072297 0.9657852 0.6305864 1.0601098 0.8738087
  6 1.1085686 0.9182902 0.8684864 1.0149355 0.7843462 0.8230971 0.7831290 0.4072297 0.9657852 0.6305864 1.0601098 0.8738087
   year
age 2014
  0 0.2101549
  1 0.7547622
  2 1.1068767
  3 1.1466387
  4 0.9506776
  5 1.0860868
  6 1.0860868

units:  f

Slot "index.name":
[1] "TUR BT"

Slot "index.range":
[[1]]
     min      max plusgroup   minyear   maxyear    startf     endf
       1        5         5      2009      2014         0        1


Slot "index":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013      2014
  1 1100.56125  928.92453 1306.18726  707.91870  630.76494  913.34808
  2  516.83791  528.02314  478.36667  255.39441  324.72621  265.31765
  3   99.57153  136.59855   68.49921   68.59964   97.14510   77.79716
  4   27.97653   24.21932   24.13370   46.66982   64.35789   12.96076
  5    5.02241    2.07678    7.32000    2.14884    2.00759    0.77999

units:  NA


Slot "index.res":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique
```

```
   year
age 2009       2010       2011       2012       2013       2014
  1  0.0791170 -0.1009064  0.2977050 -0.2343695 -0.0155521 -0.0224495
  2  0.2739018  0.0532462  0.1068199 -0.3638872 -0.0291520 -0.0270449
  3  0.0262396  0.3439004 -0.3283227 -0.3227832  0.2516116  0.0345669
  4  0.7654835 -0.1881588  0.5170508  0.4810940  1.1530525 -0.0799089
  5  0.0286420 -0.0407985  0.0219574 -0.0531587  0.0607671 -0.0030665

units:  NA


Slot "index.hat":
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An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013      2014
  1 661953.17 558719.05 785630.79 425790.96 379385.39 549350.31
  2 213821.06 218448.50 197905.12 105659.25 134342.51 109764.59
  3  42709.95  58592.22  29381.87  29424.95  41669.17  33370.11
  4  12000.18  10388.57  10351.85  20018.43  27605.50   5559.36
  5   2154.30    890.81   3139.82    921.72    861.13    334.57

units:  NA


Slot "index.var":
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An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013      2014
  1 0.0379684 0.0379684 0.0379684 0.0379684 0.0379684 0.0379684
  2 0.0523775 0.0523775 0.0523775 0.0523775 0.0523775 0.0523775
  3 0.0934449 0.0934449 0.0934449 0.0934449 0.0934449 0.0934449
  4 0.5791275 0.5791275 0.5791275 0.5791275 0.5791275 0.5791275
  5 0.0022462 0.0022462 0.0022462 0.0022462 0.0022462 0.0022462

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0         6         6      1990      2014         2         5

Summary
        ssb      fbar       rec    catch landings
1  6032.300 0.9309472  444909.3 3637.742     3639
2  5738.840 1.0535960  527560.8 3819.391     3820
3  6317.404 0.7794107  546205.1 3024.134     3025
4  7416.027 0.6889425  478042.6 2877.263     2879
5  8950.630 0.3534946  385185.5 2361.039     2362
6  8610.502 0.6462968  259554.1 4670.066     4672
7  5605.090 1.0423399  246707.9 5493.883     5495
8  3374.004 1.0889913  323725.9 3107.085     3108
9  2662.790 1.4733777  342887.1 2569.869     2655
10 2507.061 1.2623536  310264.7 3083.483     3081
11 2243.125 1.0529419  219141.9 2488.929     2487
12 2150.919 0.9713490  219495.0 1623.380     1643
13 1968.816 1.0854985  288914.5 1736.918     1731
14 2350.116 0.9004058  413554.9 1290.443     1286
15 3440.294 0.8381408  615898.8 1303.525     1303
16 2921.609 0.9779399  575630.1 1802.969     1801
17 3230.853 0.7577451  674550.2 1452.299     1501
18 3710.620 0.7947883  868507.9 1884.515     1791
19 3057.871 0.7565919 1284635.7 1796.539     2089
20 3843.074 0.6438178 1332470.9 2623.949     2637
21 3789.342 0.9283866 1258408.6 3947.662     3952
22 3595.847 0.7396135 1214352.6 3522.806     3520
23 3075.495 1.1703693  862997.8 3487.895     3491
24 2559.066 1.2699357 1181298.4 2495.306     2500
25 2645.225 1.0725700  768717.8 3898.727     3895
```

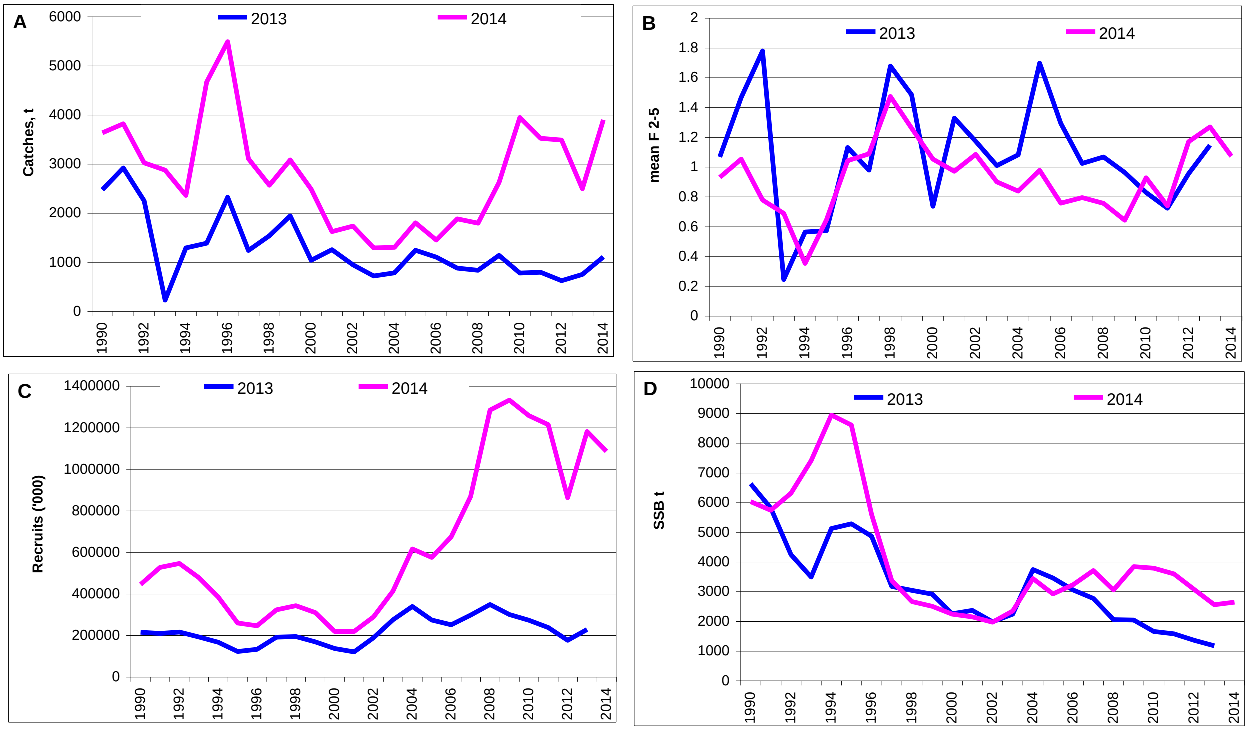


Fig. 5.2.3.7.3.4. Red mullet in GSA 29. Comparison between A; Catches; B; mean F; C; Recruitment, and D; SSB of red mullet as estimated in the 2013 and 2014 assements

This year assessment (2014) differs considerably from the previous (2013) assessment (Fig. 5.2.3.7.3.4), because different input catch data were used (catches reported as Red mullet and Striped mullet were pulled together, see chapter 5.2.3.5.4). Resulting average F follows a similar trend to the 2013 assessment, except in the period 2004-2009, while SSB and recruitment differ considerably from the 2013 assessment (Fig. 5.2.3.7.3.4).

5.2.3.8 Reference points

5.2.3.8.1 Methods

A YPR analysis has been performed based on the current assessment data

5.2.3.8.2 Input data

As for the red mullet assessment Table 5.2.3.7.2.1 and Table 5.2.3.7.3.2.

5.2.3.8.3 Results

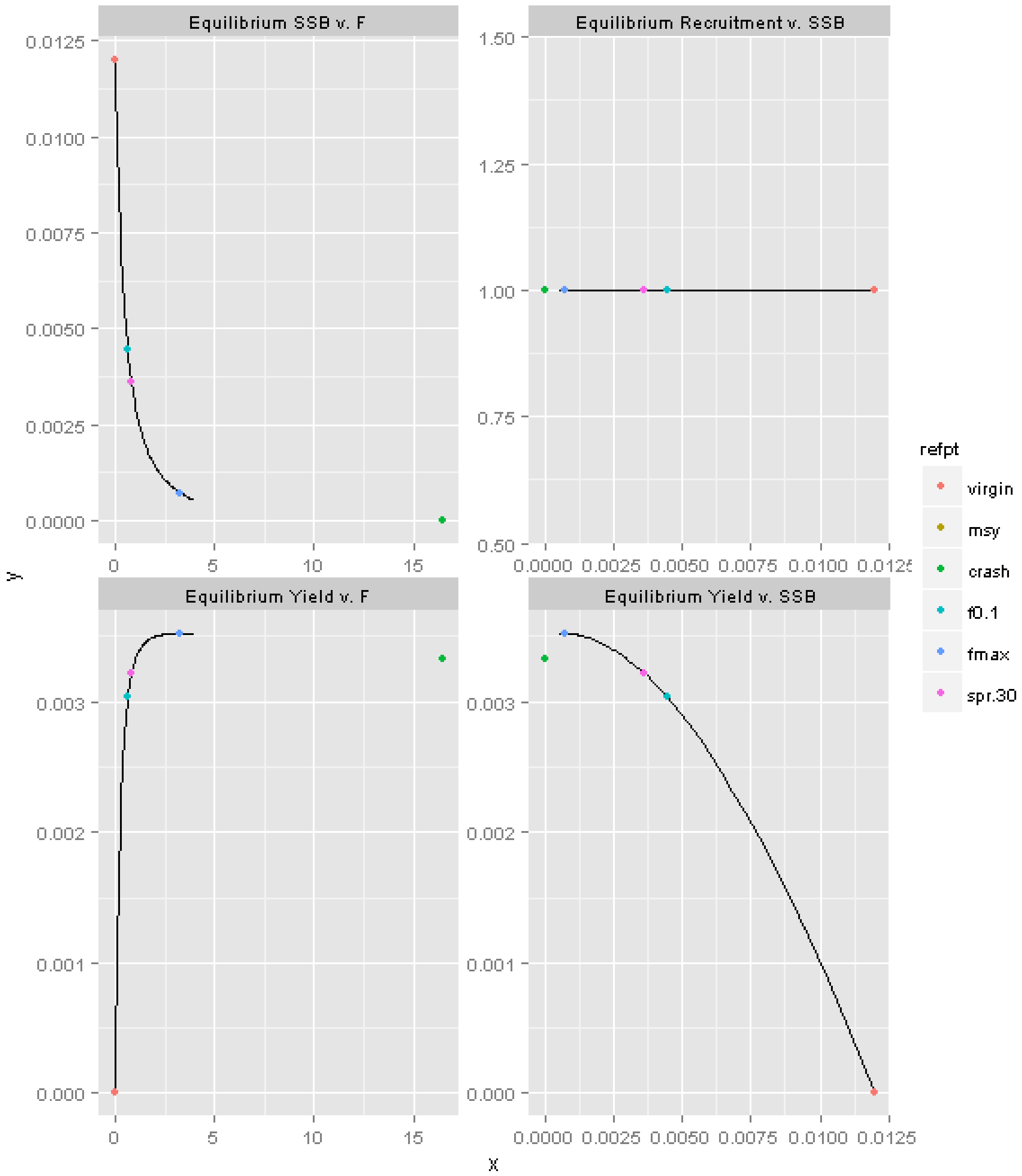
An object of class "FLPar"

quantity

refpt	harvest	yield	rec	ssb	biomass	revenue	cost	profit
virgin	0.0000e+00	0.0000e+00	1.0000e+00	1.1996e-02	1.6828e-02	NA	NA	NA
msy	3.2854e+00	3.5231e-03	1.0000e+00	7.1226e-04	3.5444e-03	NA	NA	NA
crash	1.6495e+01	3.3301e-03	1.0000e+00	4.9525e-06	1.3223e-03	NA	NA	NA
f0.1	6.4120e-01	3.0365e-03	1.0000e+00	4.4327e-03	8.5683e-03	NA	NA	NA
fmax	3.3032e+00	3.5231e-03	1.0000e+00	7.0630e-04	3.5334e-03	NA	NA	NA
spr.30	8.2693e-01	3.2167e-03	1.0000e+00	3.5989e-03	7.5793e-03	NA	NA	NA

mey	NA	NA	NA	NA	NA	NA	NA	NA

units: NA



YPR analysis. $F_{0.1}$=0.64.

5.2.3.9 Data quality

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of a research trawl survey and to the uncertainties in the identification of the fish species in the catches.

5.2.3.10 Short term predictions 2015-2017

5.2.3.10.1 Method

No short term forecast was performed as the assessment is only indicative of trends

.

5.2.3.11 Medium term predictions

5.2.3.11.1 Method

Not conducted.

5.2.3.12 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level (0.64), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of red mullet in GSA 29 in 2016 consistent with F_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.2.4 STOCK ASSESSMENT OF ANCHOVY

5.2.4.1 Stock Identification

There are two subspecies of anchovy in the Black Sea: the Black Sea anchovy, *Engraulis encrasicolus ponticus* and the Azov Sea anchovy, *Engraulis encrasicolus maeticus* (Ivanova et al., 2013); each forming isolated stocks (Ivanov and Beverton 1985, Chashchin 1995). The latter reproduces and feeds in the Azov Sea and spend the winter along the northern Caucasian and Crimean coast of the Black Sea. In addition to these two distinct stocks, there are strong evidences for the existence of a resident stock, spawning within the Turkish EEZ and overwintering on the Anatolian coast. An alternative view to existence of more than two stocks is displacement in the spawning areas (Niermann et al. 1994). The degradation of ecological status of the spawning area is believed to lead in anchovy shifting its spawning areas. The common belief is that the Black Sea anchovy migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea in October-November (Ivanov and Beverton, 1985; Chashchin, Shlyakhov et al.2015). In these areas they form dense hibernating concentrations until March. During this period they are subjected to intensive fishery. In the rest of the year they occupy spawning and feeding habitats across the sea with some preference to the shelf areas characterized by high productivity (Faschuk *et al*. 1995, Daskalov, 1999).

On the other hand in the view of new findings, to what extent the different forms of anchovies are discriminated in the landings and as to whether they are subjected to the same nutritious conditions for growth and reproduction and to the same level of natural and fisheries mortality, are a matter of assessment concerns. It is crucial to address the question of stock unit for anchovy in the Black Sea. In this assessment it was assumed that *i*) there are only two stocks of anchovy in the Black Sea; ii) the Azov Sea anchovy inhabits region confined to Sea of Azov, east of Crimean and Caucasian coast and to an extent Georgia; iii) this stock is almost exclusively fished and hence regulated by Ukraine and Russian Federation. Therefore the assessment is populated with the data pertaining only to the Black Sea anchovy, excluding the catches from the Azov Sea.

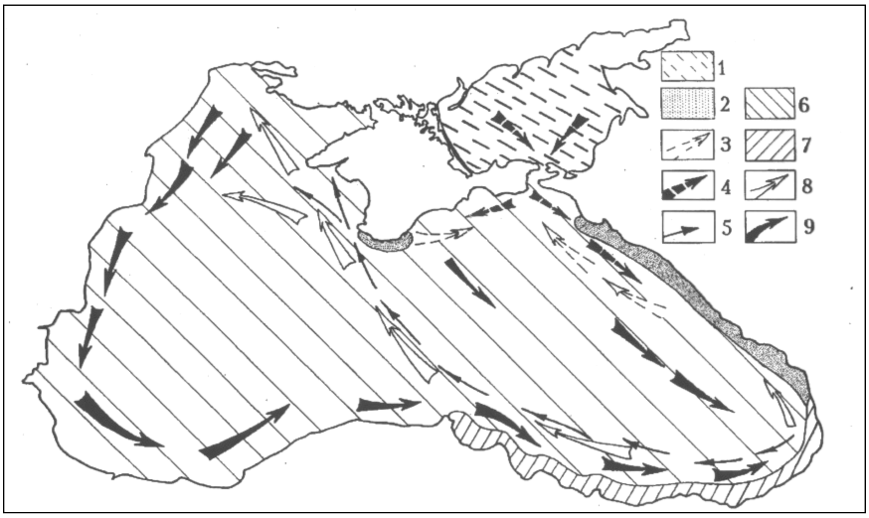


Figure 5.2.4. Error! No text of specified style in document..**1**. The spawning areas and scheme of the anchovy migrations (Chashchin, 1995). The Azov anchovy: 1 — spawning and foraging region; 2 — wintering region; 3 — spring migrations; 4 — autumnal migrations; 5 — periodical migrations of a mingled population. The Black Sea anchovy: 6 — spawning and foraging region; 7 — wintering region; 8 — spring migrations; 9 — autumnal migrations.

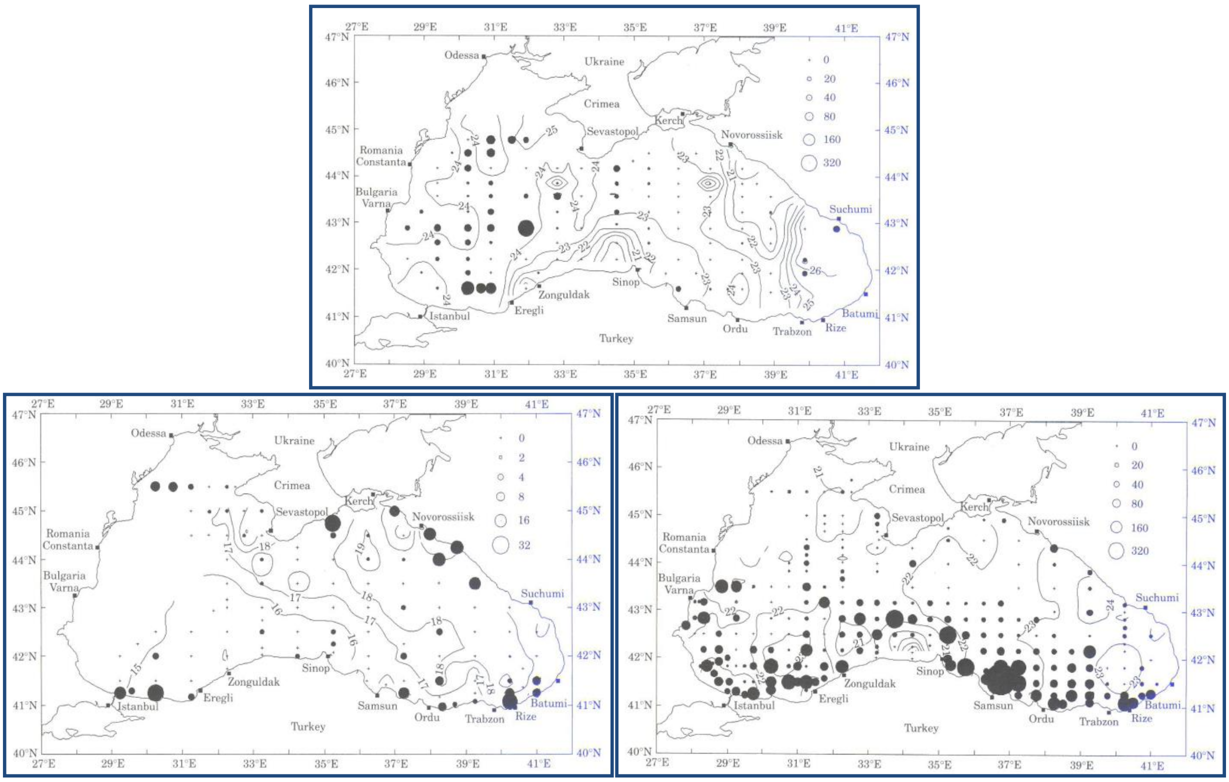


Figure 5.2.4. Error! No text of specified style in document..**2.** Egg distribution of anchovy in 1950s (upper left; Einarson and Gürtürk 1960); and in 1990s (lower, Niermann et al. 1994).

5.2.4.2 Growth

Anchovy is a short lived species. During the last 30 years, the catch has been represented only by individuals of 0 to 4 years age: the older ages (4 and older) are very rare and not frequently observed in the area. The two anchovy forms (Azov and Black Sea) grow differently; the former growing slower (Chashchin,1996). Therefore it may be worth noting that a growth estimate disregarding stock discrimination would produce results with great variance. The growth estimates reported in the literature are based on mean length of age classes. There are significant differences in mean lengths of the age classes provided by the countries. Figure 5.2.4.1.3 displays the length frequency distributions of Bulgaria, Romania and Turkey. The smallest anchovies were observed in Romanian catch while the largest are in the Bulgarian waters. The overall size range is between 4 and 14.5 cm. In this assessment, the differences were assumed to occur due to differences in the time of sampling; ie. Bulgarian catch represents the summer months when the fishes are about to complete a year cycle; Romanian data displays the size of the anchovies at the time of recruitment; the Turkish data represents the length frequency distribution of anchovies during winter.

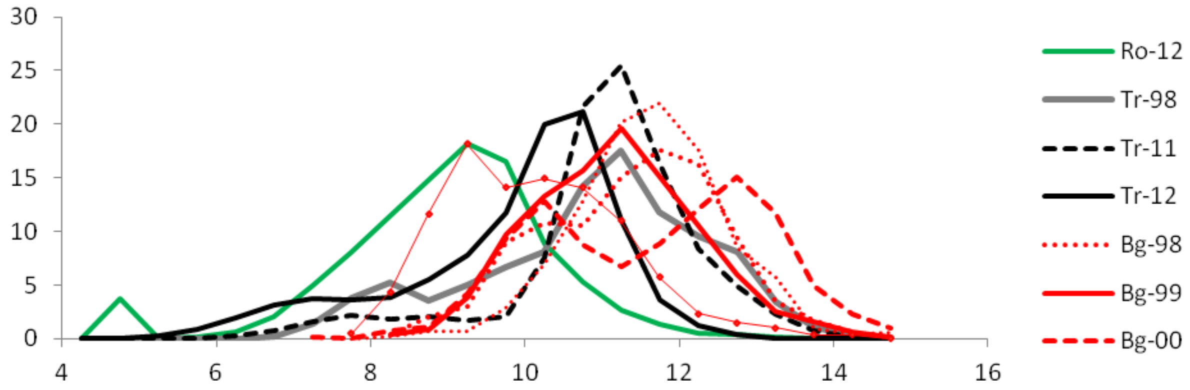


Figure 5.2.4. Error! No text of specified style in document.**.3.** Anchovy in GSA 29. Length-frequency distributions reported by different countries.

Another important point in the anchovy growth is the seasonality. The growth which is very fast during summer, almost ceases during winter. Almost every winter a significant drop in the somatic condition of the overwintering anchovy is reported (Gucu, 2002).

In 2012-2014 the increase in the proportion of Azov anchovy took place in the Ukrainian Black Sea area. The reason for this was the increase in the stock of anchovy in the Sea of Azov to the level of 500-600 thousand tons (Chashchin, Shlyakhov et al., 2015). In winter a considerable part of the Azov anchovy migrated to the west and in spring time remained for spawning in the shallow water north-western part of the Black Sea in the brackish-water zone.

5.2.4.3 Maturity

First maturity age is year 1 for anchovy. It spawns during the summer, from mid May to the second half of August with a peak from mid-June to the end of July. This period is also the main feeding and growth season. The main feature characterizing the summer habitat is the strong stratification of the water due to the seasonal thermocline and reinforced in coastal and shelf waters by the river plumes. Anchovy was found to spawn mainly in the surface layer of these warm and stratified areas (Arkhipov, 1993; Fashchuk et al. 1995). Eggs and larvae are retained in the coastal layer stabilized in depth by the thermocline and protected from the offshore by thermo-haline fronts. A large convergence zone is formed on the northwestern and the western shelf (the main anchovy spawning area) due to the river Danube inflow, which favors fish offspring retention (Radu and Maximov 2006-2008). Lisovenko and Andrianov (1996) estimated that a mature anchovy may produce 50 batches and the average number of eggs spawned by one female varies between 138 000 and 231 000 displaying a clear seasonal indeterminate pattern. Interestingly the same authors observed that a small part of each new generation of anchovy reach sexual maturity and spawn two-three months after hatching, at the end of the spawning season. The part of the spawning 0 year class in the population may be as high as 1.5%.

5.2.4.4 Natural mortality

Experts provided several estimates for natural mortality M varying from 0.4 to 1.2:
Bulgaria - 0.85;
Ukraine - 1.07;
Turkey – 1.26 by Pauly's formula and for age groups

Age group	0+	1+	2+	3+	4+
Gislason's method	1.552	1.011	0.837	0.739	0.739

For the current assessment, M was estimated based on Gislason method as in 2014.

5.2.4.5 Fisheries

5.2.4.5.1 General description of the fisheries

The summer distribution area of the Black Sea anchovy covers entire Black Sea (Figure 5.2.4.1.1.). However due to the dispersed spawning distribution, the Black Sea stock is not a target of the fishery during summer. During the spring and autumnal migrations anchovy was caught by coastal trap nets and beach seines mainly in Bulgaria, Romania and Ukraine however historically it was also caught by coast traps along the Istanbul strait. The main Black Sea anchovy fishery however has been carried out by purse seiners and the fleet targeted the schools over the overwintering ground located on the Turkish and Georgian waters for more than 50 years. During the years between 1960 and 1990 the anchovy catch of the countries located on the migration route has increased gradually and reached to a maxima in the first half of 1980s (Figure 6.5.1). Almost synchronously, the anchovy catch of all Black Sea countries dropped in the second half of the 1980s. The reasons of the collapse has been evaluated by various authors and are: fishing pressure; distrophication by Danube River and degradation of the ecosystem on the main feeding and spawning ground; destruction at the lower trophic levels of the Black Sea ecosystem by the intrusion of an alien gelatinous species *Mnemiopsis leidyi* were some of the factors hypothesised. Following the three years after the collapse, the Black Sea anchovy stock seemed to recover as can be seen from the increase in the Turkish landings (Figure 5.2.4.5.1.1). However, the catch of the countries on the migration route of the species has never been increased but even reduced. This situation is explained by the drastic drop in the number of fishing vessels and pond nets in these countries; however it may also be an indication of habitat shift and or change in the migration route. In recent years, catches have remained low in Turkey and in 2014 fell to a historical minimum over the past 25 years. However, it might also be due to the negative impact of alien species (i.e. *Mnemiopsis and Rapana*) on the marine environment. In the most important area of anchovy spawning and feeding, in the north-western part of the Black Sea, the widespreading of Rapana, which predate on mussels, affected negatively the water clarity. Finally, the negative impact of *Mnemiopsis leidyi* still exists despite the spreading of its predator, the ctenophore Beroe in the Black Sea (Chashchin, Shlyakhov et al., 2015).

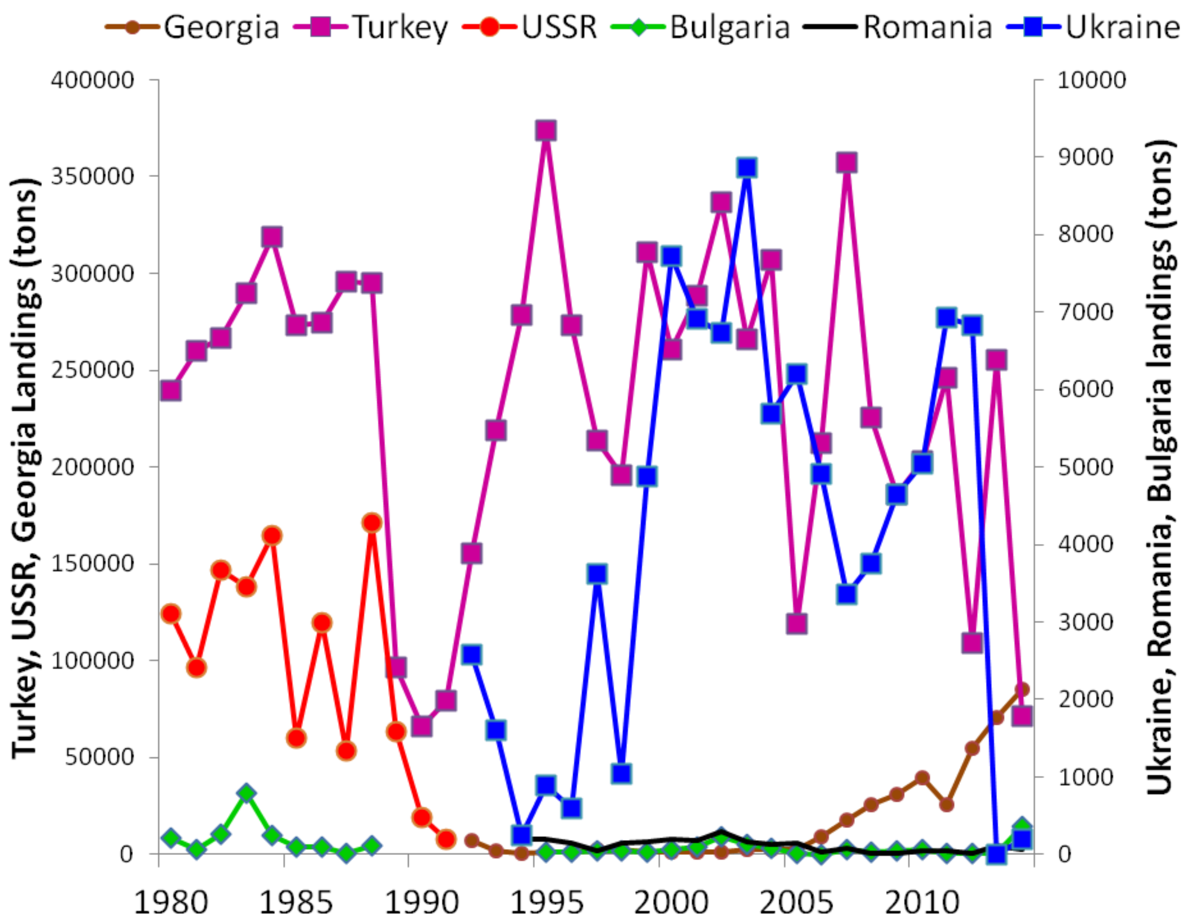


Figure 5.2.4.5.1.1. Anchovy in GSA 29. Annual landings.

5.2.4.5.2 Management regulations applicable in 2015

In the Black Sea countries, anchovy fisheries are generally regulated by i) closed seasons (May April to October/November for Bulgaria and Romania, April to September for Turkey, and no closed season for Ukraine), ii) closed areas, iii) mesh size regulations, iv) minimum landing size (9 cm total length in general and 7 cm TL for Georgia, allowable minimum length size is not applied for the Black Sea anchovy in Ukraine). The Black Sea and Azov anchovy are treated as two different stocks in Ukraine and in the Russian Federation and the fishery is managed separately for each stock.

Turkey, having the main fleet fishing the Black Sea anchovy, enforced additional measures to control the size of the fishing fleet. These include:

a) fishing capacity had developed over the years and finally overcapitalized beyond profitability within the last 3 decades. The issue and its consequences on the fish stocks have been recognized in mid-1990s when a significant reduction in the stocks hit the fishing sector. However a comprehensive measure has been enforced only at the beginning of 2000's. As a first step, licensing new fishing boats has been stopped in 2002 with the aim of reducing the fishing pressure on the stocks and to maintain sustainable fisheries. Despite interruptions during 2004 and 2005, the applied policy had positive effects on control of increasing fleet capacity. Since then, new entries to the fleet are only allowed when a vessel of same size is exiting from the fleet. In summary the size of the main anchovy fishing fleet in the Black Sea is stable since 2005.

b) another very substantial and promising remedy is the fishing boat buyback program launched in 2012 and repeated in 2013. Given that by far the greatest part of the catch is landed by the industrial boats, the first phase of the program targets fishing vessels larger than 12 meters in 2012. Although the ultimate goal is to reach greater percentages in time, with the available funds allocated for the buyback program only 407 boats (156 boats of them were registered to the port on the Black Sea coast) has been removed from the fleet at this first phase in 2013. In the second phase launched in 2014 another 529 boats have been decommissioned within this campaign.

c) a series of new regulations and methodological reforms have been enforced within the last 2 years to enhance accuracy of the landing statistics,

d) as of 18.08.2012 the minimum depth limit allowed for purse seine and for pelagic trawls has been increased from 18 to 24 meters. Considering that the anchovy overwintering on the Anatolian coast are confined to 0 to 100 meters, the regulation has noticeable positive effect on the reduction of fishing pressure on the anchovy stocks.

5.2.4.5.3 Catches

The anchovy fleet is characterized by purse seiners. The largest fleet targeting Black Sea anchovy belongs to Turkey. In this country the vessels usually coupled with a carrier boat. In some years when the sprat fishery is not profitable or anchovy schools are dispersed over wide areas, pelagic trawlers also take part in the anchovy fishery. Other gears, such as gillnet, coastal trap or pound nets, make negligible contributions to the total landings in Turkey. However coastal traps are very usual in anchovy fishery in the north-western part of the Sea (Romanian and Ukrainian zones), although the catches of these traps were strongly reduced in the last two decades. In accordance with a bilateral agreement, since 2003, a small part of the Turkish purse seiners move to Georgian waters as soon as the Black Sea anchovy season is over on the Turkish coast. These boats are licensed to catch anchovy within the jurisdictional waters of Georgia and their catch is landed and registered at the Georgian ports. Although only 10% of the fishing boats moved to Georgia in 2013 and took part in anchovy fishery, the quantity of the fish landed in Georgia is almost 1/3 of the Turkish anchovy landed in Turkey. Apparently the catch rates are much higher in Georgian waters. This is most probably a consequence of the different minimum size regulations applied between the countries. It is important to note that catches of anchovy in 2014 are at historical low, even lower than the collapse in the 1990's and during the *Mnemiopsis* invasion.

5.2.4.5.4 Landings

The following table lists the landings (tons) by nation.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine*	USSR*	Total*
1980	209				239289		124100	363598
1981	70				259767		96222	356059
1982	266				266523		146834	413623
1983	784				289860		137918	428562
1984	239				318917		164841	483997

1985	92				273274		60395	333761
1986	96				274740		119781	394617
1987	13				295902		53482	349397
1988	115				295000		171452	466567
1989					96806		63289	160095
1990					66409		18824	85233
1991					79225		7906	87131
1992		6871			155417	2572		164860
1993		1656			218866	1598		222120
1994		857	197		278667	242		279963
1995	35	1301	190		373782	888		376196
1996	23	1232	140		273239	596		275230
1997	44	2288	45		213780	3623		219780
1998	48	2346	146		195996	1039		199575
1999	36	1264	155		310801	4872		317128
2000	64	1487	204		260670	7719		270144
2001	102	941	186		288616	6915		295760
2002	237	927	296		336419	6739		344618
2003	131	2665	160		266069	8868		277893
2004	88	2562	135		306656	5687		315128
2005	14	2600	154		119255	6200		128223
2006	6	9222	23		212081	4907		226239
2007	60	17447	87		357089	3363		378046
2008	28	25938	15		225344	3761		255086
2009	42	31338	21		185606	4653		221660
2010	65	39857	50		203026	5051		248049
2011	18	25919	41		246390	6932		279300
2012	7	55000	18		109187	6823		171036
2013	10	70700	111		255309	0		326130
2014	370	85000	62	300	71530	200		157462

*Official FAO statistics is adjusted by the value of Azov anchovy by-catch (Chashchin, Shlyakhov et al. 2015)

5.2.4.5.5 Discards

Only two countries reported anchovy discards; Romania and Turkey. The values are quite low compared to landings. The only exception is 2012 when the total catch was dominated by 0 year class. Due to minimum landing size regulations strictly applied in Turkey the rate of discard has increased in that year. In the assessment, the discards reported by the countries were not elaborated separately but simply added to the landings.

5.2.4.5.6 Fishing effort

Table 5.2.4.5.6.1. Anchovy in GSA 29. Effort, CPUE of the commercial fleets and estimates from the surveys.

Year/data	Turkish purse seine		Georgian (Turkish) fleet		USSR		USSR/Ukraine [1]	
	Effort	CPUE	Effort	CPUE	Effort	CPUE	Hydroac. Surv., t	Trawl surv.

								SSB, t
1970	18	3728			147	861		
1971	18	3631			156	710		
1972	24	3579			197	673		
1973	25	3369			174	1312		
1974	29	2441			200	867		
1975	41	1420			165	1433		
1976	53	1283			157	970		
1977	58	1230			154	877		
1978	69	1524			153	830		
1979	78	1714			141	884		
1980	104	2301			162	593		270000
1981	121	2143			159	926	330000	320000
1982	145	1838			170	811	325000	150000
1983	162	1789			126	1312	550000	300000
1984	171	1865			151	400	270000	190000
1985	195	1401			141	847	135000	150000
1986	210	1308			114	857	235000	50000
1987	229	1292			102	318	350000	100000
1988	247	1194			102	45	350000	235000
1989	262	369			103	55	150000	32000
1990	280	237			101	68	no data	48000
1991	284	279			100	16	0	92000
1992	163	953			101	9	165000	
1993	287	763			101	13	no data	
1994	243	1147			101	12	no data	
1995	262	1427			101	23	no data	
1996	278	983			101	23	no data	
1997	248	862			101	13	190000	
1998	209	938			100	15	300000	
1999	199	1562			100	9	350000	
2000	262	995			100	9	380000	
2001	299	965					280000	
2002	419	803					250000	
2003	500	563	27	99			250000	
2004	443	790	55	47				
2005	565	240	68	38				
2006	502	496	74	125				
2007	528	755	55	317				
2008	589	398	23	1128				
2009	501	384	18	1741				
2010	428	496	19	2098				
2011	400	534	16	1620				
2012	354	373	15	3667				
2013	218	779	21	3367				
2014	115	622	21	4048				

1) Chashchin, 2015

5.2.4.6 Scientific surveys

Research surveys were conducted in the Soviet Union and Georgia regularly in the last 80-90 years of the previous century (Table 5.2.4.5.6.1.). However, to date we do not have data on the age composition of the anchovy at those time. Several surveys were conducted also in the area of Turkey in recent years. Turkish surveys were used in exploratory stock assessment but the results were not satisfactory and thus they were excluded from the final XSA assessment.

5.2.4.7 Stock Assessment

5.2.4.7.1 Methods

XSA, when applied to short lived species such as anchovy, has considerable drawbacks. Yet, lack of harmonization in the otolith interpretations among different countries and even among the experts of the same country weakens the appropriateness of the method for anchovy stock assessment. On the other hand the anchovy stock in the Black Sea was first assessed by STECF in 2011 and XSA has always been the major method used for assessment since the very beginning. Therefore in this assessment the priority is given to this method to ensure consistency with the previous works.

5.2.4.7.2 Input data

Table 5.2.4.7.2.1. Anchovy in GSA 29. Data used in XSA assessment.

LA(1)	catch in tonnes	1988 - 2014	Total
CN(2)	catch-at-age in numbers	1988 - 2014	0 - 4+
CW(3)	Weight-at-age in the commercial catch	1988 - 2014	0 - 4+
SW(4)	Weight-at-age of the spawning stock	1988 - 2014	0 - 4+
NM(5)	natural mortality	1988 - 2014	0 - 4+
MO(6)	Proportion mature-at-age	1988 - 2014	0 - 4+
PF(7)%	of fishing mortality before spawning	assumed 0.00	
PM(8)%	of natural mortality before spawning-	assumed 0.00	
TUN			
CPUE of Turkish purse seine fleet		1988 - 2014	

XSA control parameters: x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.5, rage=3, qage=4, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

The anchovy landings by countries can be traced back to 1950s. However neither age nor length composition data is available before 1988. The historical catch at age data used in the XSA assessment was taken from the previous assessment carried out in 2012. In the previous assessments (2010 and 2011), experts provided data pertaining to their countries. In 2012, Turkish catch at age data was re-estimated based on length-frequency distribution of the commercial catch monitored by Trabzon Fisheries Central Fisheries Research Institute (SUMAE) and the ALKs provided by the same institute. To fill the gaps in the missing years some literature data were also used. In 2011, 2012 and 2013 the data collected within the Turkish Fisheries Data Collection Framework (TrFDCF) was simply added to the historical data.

Catch-at-age data for 2014 are derived from the raised national landings statistics by countries and added to the historic catch at age data set compiled during the previous meetings. SOP correction was applied to level off the inconsistency in the model derived and actual landings. In 2012, a remarkable part of the 0 year class anchovies were discarded, and estimated discard was treated as unreported catch and simply added to the official landings and to the catch at age data. In 2013 and

2014 (apparently recruitment was not as strong as in 2012) discarded anchovy was negligibly low and thus they were considered as negligible.

The countries provided the mean weights of the age classes; for the data concerning the Turkish catch during the period between 1988 and 2010 were taken from SUMAE. For the 2011-2014 period TrTDCF was used.

Table 5.2.4.7.2.2. Anchovy in GSA 29. Catch at age (10^6).

Year/age	0	1	2	3	4+
1988	2165842	15011518	13371602	579129	0.001
1989	16430588	5220147	252370	81006	0.001
1990	16682296	1243132	403251	125648	0.001
1991	10515780	4523684	854903	45262	0.001
1992	13457543	12080268	1177327	26407	0.001
1993	19240499	15583511	2629967	147657	0.001
1994	42079752	15897946	2939827	24386	0.001
1995	25590787	21918772	8556294	1236664	0.001
1996	16213594	15724393	6964770	947668	0.001
1997	5838738	13528032	6155538	768176	0.001
1998	5393433	12464597	5659399	705716	111
1999	8812114	20147374	8969151	1117438	68
2000	7322427	17378033	7606441	947861	229
2001	1647360	12232027	11844515	2312884	0.001
2002	1800825	14500081	13827570	2700455	0.001
2003	1573805	11757985	10970980	2135997	0.001
2004	8113535	16438121	9020434	718386	0.001
2005	6033023	3666938	4598032	325143	0.001
2006	14559142	11646123	4848459	162853	0.001
2007	23494265	19872673	7563556	224247	0.001
2008	8219549	12261714	8570209	318182	0.001
2009	10249653	9531493	5185010	199283	0.001
2010	7323812	10027425	9899744	428497	0.001
2011	9225602	13582799	6086328	326309	66482
2012	23786624	10899264	2191995	218372	149377
2013	5394813	21266934	5805574	392522	0.001
2014	3465000	13140000	6939000	664500	118600

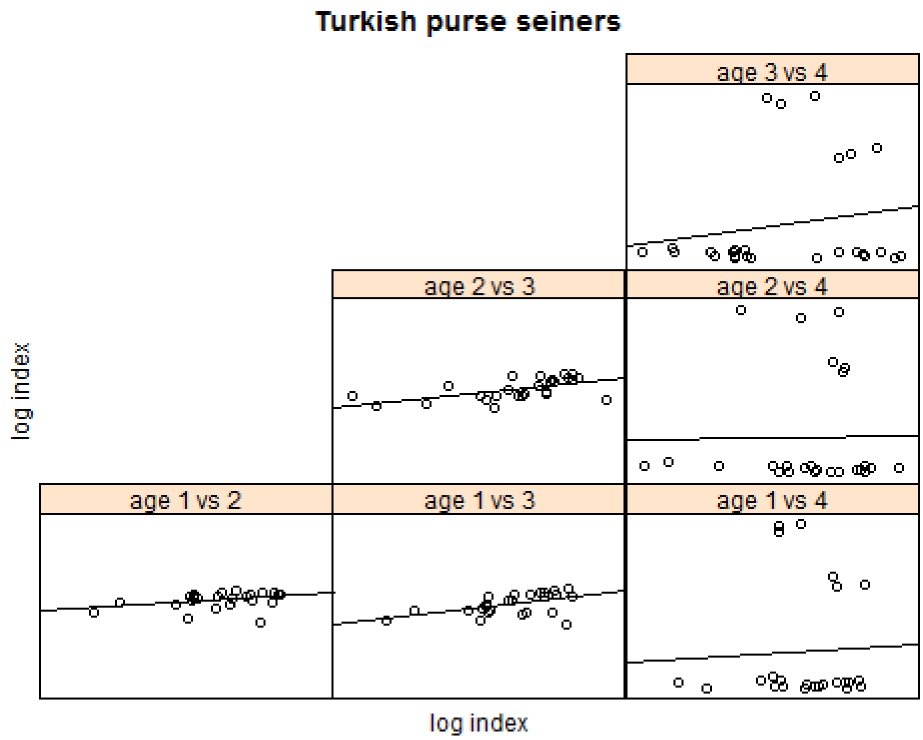


Figure 5.2.4.7.2.1. Anchovy in GSA 29. Internal consistency plot of the first tuning data (Turkish commercial CPUE).

5.2.4.7.3 Results

The XSA model was tested for its sensitivity for the shrinkage used and 5 different values, 0.5, 1.0, 1.5, 2.0 and 2.5. The outputs of the model results are presented in the graphics given below. As there are not much differences in the outcomes the settings used in the 2013 (fse=1.5), which gave lower and randomly distributed residuals (Figure 5.2.4.7.3.6.) and a satisfactory retrospective analysis (Figure 5.2.4.7.3.5.) were used for the 2014 assessment.

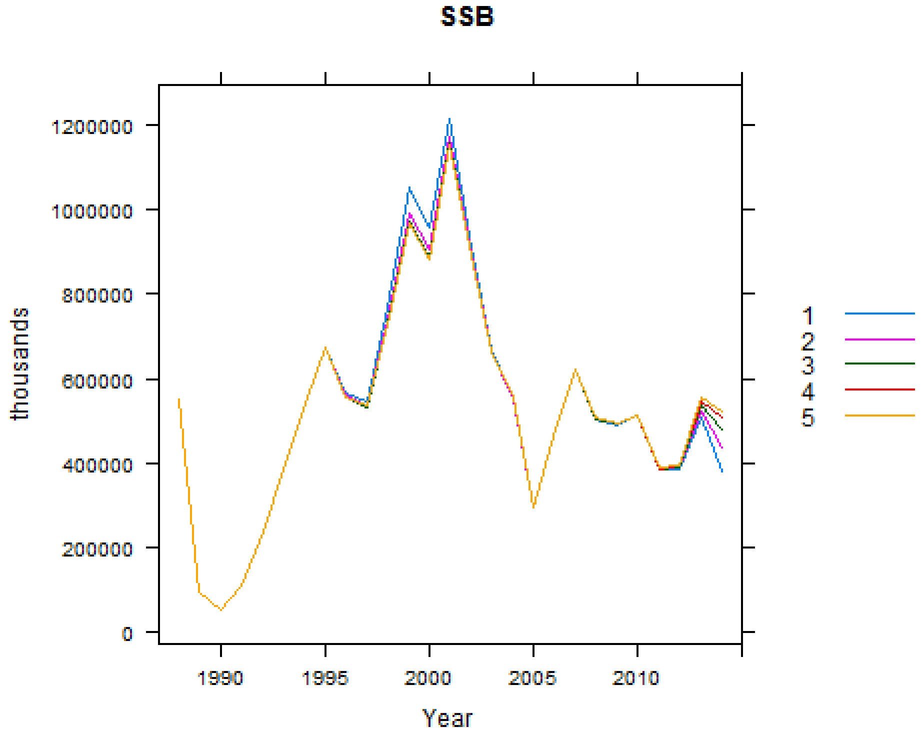


Figure 5.2.4.7.3.1. Anchovy in GSA 29. XSA results: Spawning stock biomass estimates by 0.5 (1), 1.0 (2), 1.5(3), 2.0(4) and 2.5(5) shrinkage.

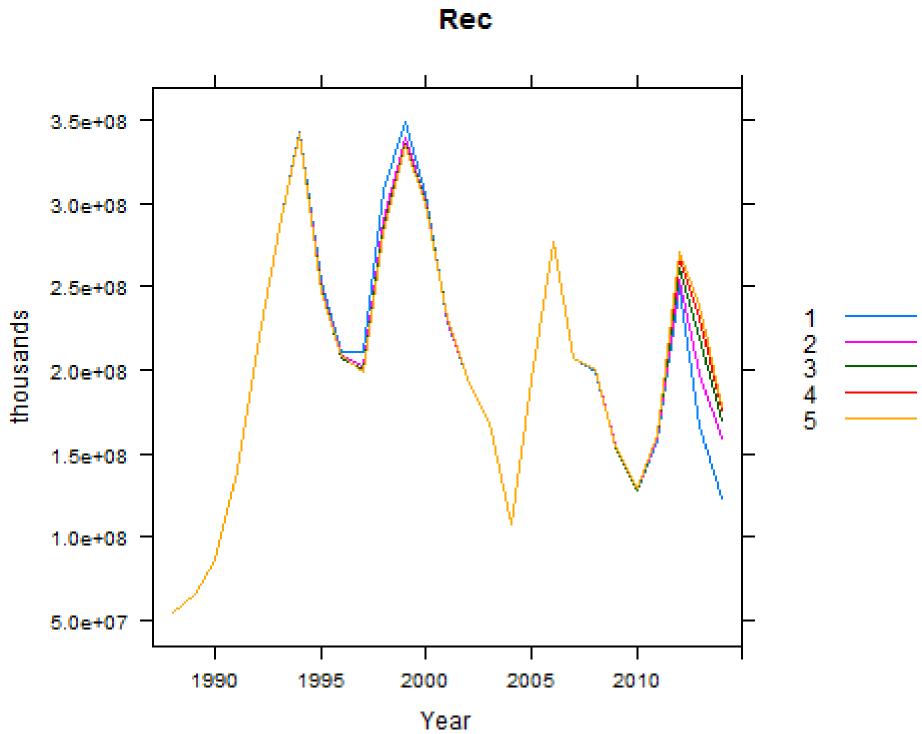


Figure 5.2.4.7.3.2. Anchovy in GSA 29. XSA results: Recruitment estimates by 0.5 (1), 1.0 (2), 1.5(3), 2.0(4) and 2.5(5) shrinkage.

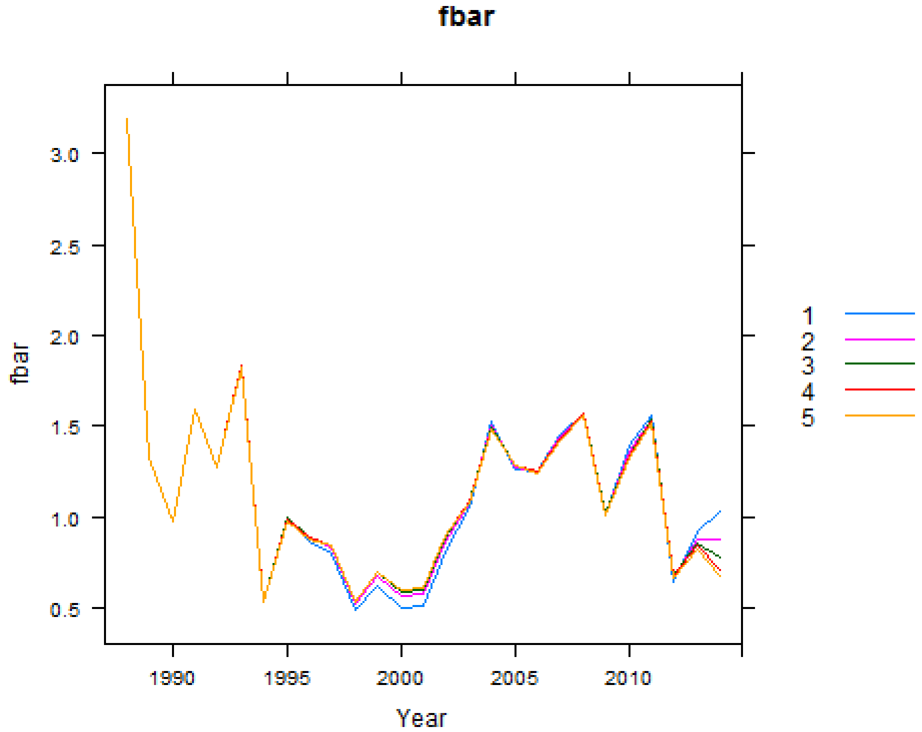


Figure 5.2.4.7.3.3. Anchovy in GSA 29. XSA results: Fishing mortality estimates by 0.5 (1), 1.0 (2), 1.5(3), 2.0(4) and 2.5(5) shrinkage.

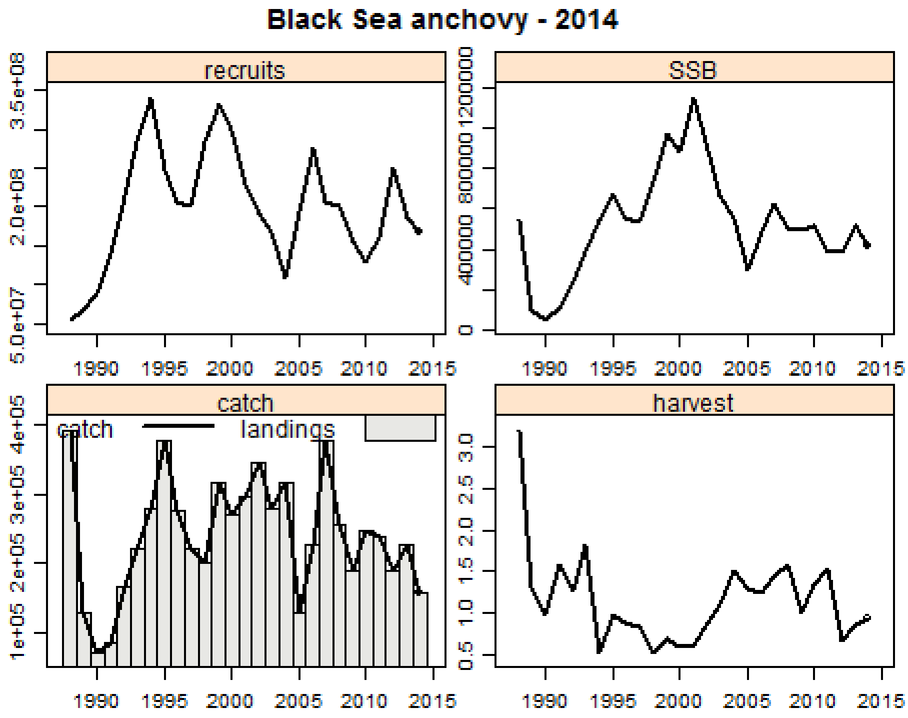


Figure 5.2.4.7.3.4. Anchovy in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

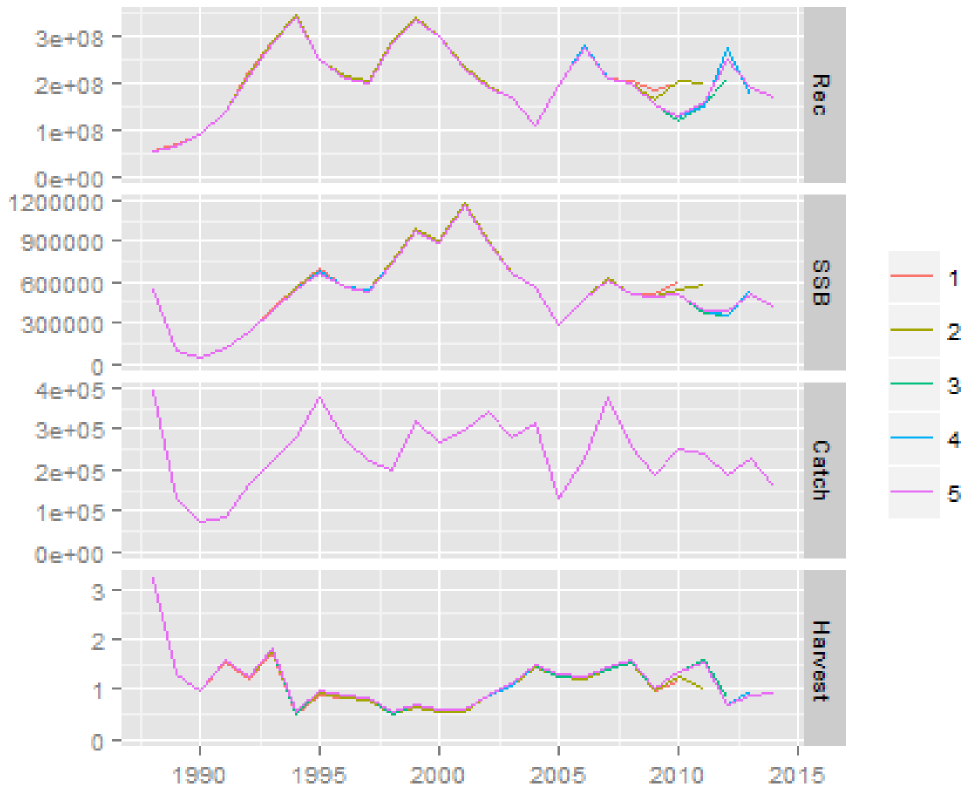


Figure 5.2.4.7.3.5. Anchovy in GSA 29. Retrospective analysis.

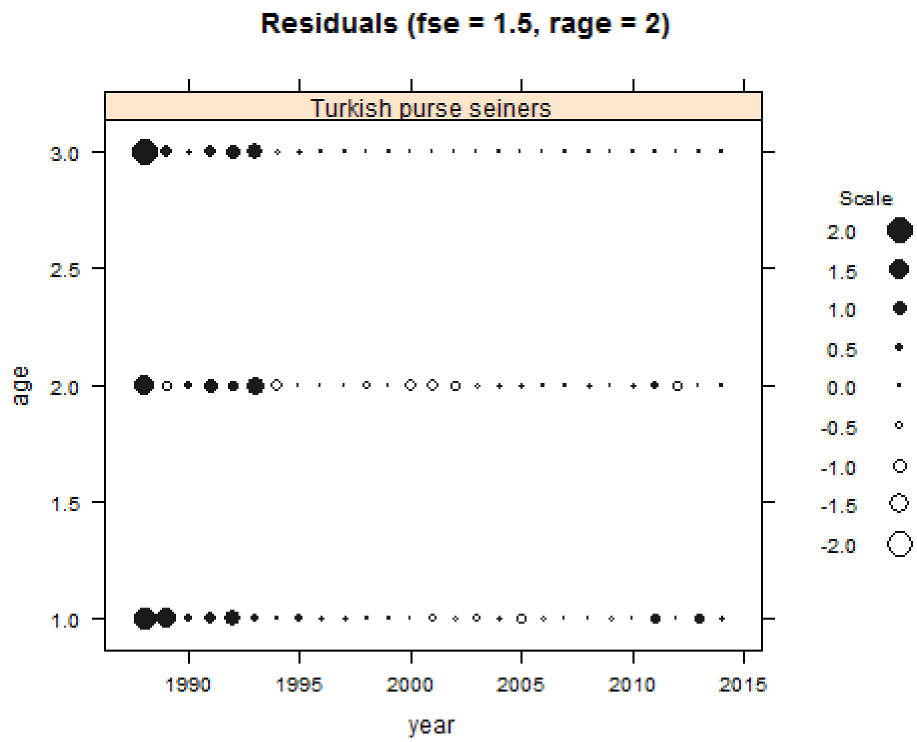


Figure 5.2.4.7.3.6. Anchovy in GSA 29. Residuals of the tuning fleet.

The results of the analysis display a very strong year class entry in 2012, which, as all assessment results agrees, increased the SSB in the following year. The F, however, which has been dropped noticeably, slightly increased in 2013 and remained almost the same in 2014. The current exploitation rate (E=0.53), estimated based on the average $F_{[1:3]}$ of the last 3 years, exceeds the precautionary threshold 0.4 recommended for small pelagic fish (Patterson, 1992). On the other hand, the high variance of the F estimates averaged over the last 5 years hampers to make meaningful short term predictions. General trend in the last ten years, however, indicates a slight decrease in the fisheries mortality.

In all model runs recruitment displayed a cyclic pattern with peaking values observed in 1994, 1999, 2006, 2012 (Figure 5.2.4.7.3.4.), which usually followed by a drop within the last 25 years. The pulse of a strong year class usually effects the next years SSB. This is what happened in 2013; the strong recruitment gave rise to the number of spawners next year. The same pattern has been observed, at varying degrees, few years after the strong recruitment years.

5.2.4.8 Reference points

5.2.4.8.1 Methods

The reference points produced by FLBRP, such as $F_{0.1}$ or F_{max} were quite unrealistic and high. Therefore Patterson's (1992) precautionary exploitation rate of E=0.4 is used to evaluate the status of the stock. The average of the last three years F was used for the calculation of F used in the estimation of exploitation rate.

5.2.4.8.2 Input data

The model estimated current $F_{[1:3;2014]}$ is 1.01. The average F of the last three years estimates, is $F_{[1:3;2012:2014]}$. = 0.82. Natural mortality is the average of all ages and estimated as 0.73.

5.2.4.8.3 Results

The current exploitation rate is estimated as E=0.53 and it exceeds the precautionary threshold 0.4 recommended for small pelagic fish. This estimate indicates that the Black Sea anchovy stock is being subjected to overfishing.

5.2.4.9 Data quality

The problem in ageing, which was faced in the previous assessment and underlined in EWG 14-14 still remains. Its reflection is very clear on the inconsistency of weight at ages reported by the countries, and more importantly on the significant difference observed in the reported and estimated landings. The difference is balanced using SOP correction however its consequences on the assessment quality could not been evaluated. In the time series there are 4 successive years of missing data (landing at age and weight at age). The gap is filled by the data published in grey literature. The results of the analysis covering that part displays extremely high SSB value. Various tests have been done to check whether or not these high values are the outcomes of incompatibility of the data used to fill the gap; however no clear answer has been reached. The survey data (hydro-acoustic) displayed very high internal inconsistency and increased the residuals remarkably, therefore they were not used. The reason is, as also stated in the EWG 14-14, the area coverage of the surveys. Anchovy is a transboundary fish, however the surveys are limited to one country. It is necessary to enlarge the geographical coverage of the surveys. The researches carried out by YugNIRO in the Crimea, have revealed the absence of Black Sea anchovy accumulations in winter period. Only few catches have been registered there . Mainly as a by-catch in the Azov anchovy fishery (A. Chashchin's report). The data concerning the part of the Black Sea that of Abkhazia (northern part of Georgia) where very intense anchovy fishing takes place, was not included in the analysis. Given that the overwintering grounds of these peripatetic fish, where were fished is, to a great extent, determined by the SST, it is not known whether the drop in the total landings is real or their overwintering grounds were expanded towards the countries who did not provided data to STECF.

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of a dedicated hydro acoustic survey.

5.2.4.10 Short term predictions 2015-2017

5.2.4.10.1

No short term forecast was performed as the assessment is only indicative of trends.

5.2.4.11 Medium term predictions

Not conducted.

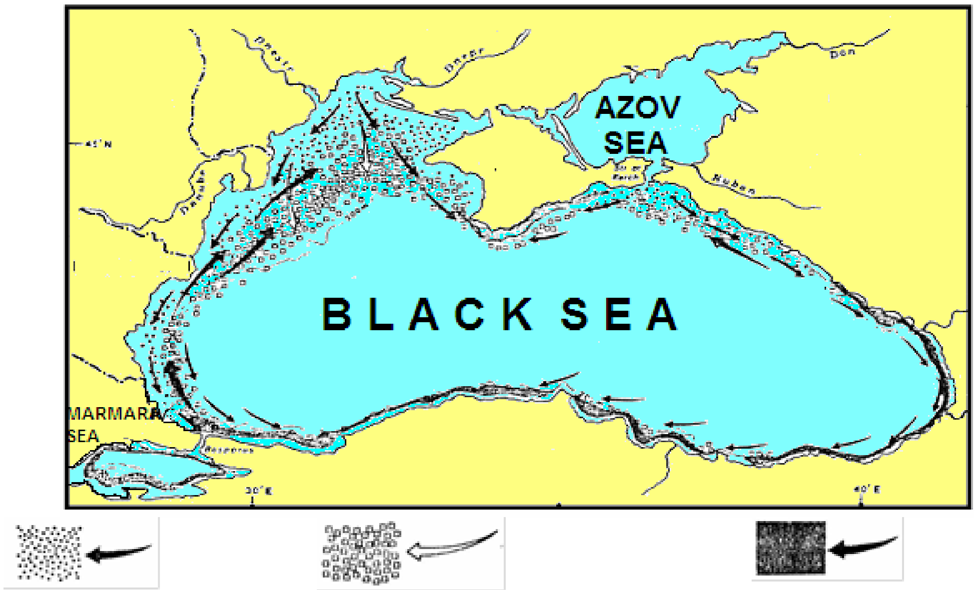
5.2.4.12 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of anchovy in GSA 29 in 2016 consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

5.2.5 STOCK ASSESSMENT OF MEDITERRANEAN HORSE MACKEREL

5.2.5.1 Stock Identification

The family Carangidae is represented by two species in the Black Sea: *Trachurus trachurus* and *T. mediterraneus* (Drenski, 1948, 1951; Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov et al., 1963; Svetovidov, 1964; Valkanov et al., 1978; Sivkov, 2004; Zhivkov et al., 2005; Kapapetkova and Zhivkov, 2006; Raykov and Yankova, 2008; Yankova et al., 2010a; Yankova et al., 2014).The Black sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus*. Although in the past the Black sea horse mackerel has been attributed to various subpopulations (Nümann (1956) and Aleev (1952, 1957), in a more recent study Prodanov et al. (1997) brought evidence that the horse mackerel rather exists as a single population in the Black sea, and thus all Black sea horse mackerel fished across the region should be treated as a single stock. Horse mackerel is a migratory species distributed in the whole Black Sea (Ivanov and Beverton, 1985, Fig. 5.2.5.1.1). Turan (2004) analyzed the population structure of *T. mediterraneus* in Turkish coastal waters using morphometric and meristic traits and reported on population structuring in three areas: the Black Sea, Marmara Sea and the north-east Mediterranean Sea. The samples from the Black Sea were similar to each other for both morphometric and meristic characters. Biometric indices were insufficient to distinguish two horse mackerel subpopulations in the Bulgarian and Turkish Black Sea waters (Yankova and Raykov, 2006a). The same authors concluded that all of the morphological differences are possible due to variability of the habitat and sample size of the study. Finally mtDNA analysis also indicated that there were no subspecies of *T. mediterraneus* from the Turkish Black Sea waters (Bektas and Belduz, 2008).



Feeding ground and migration

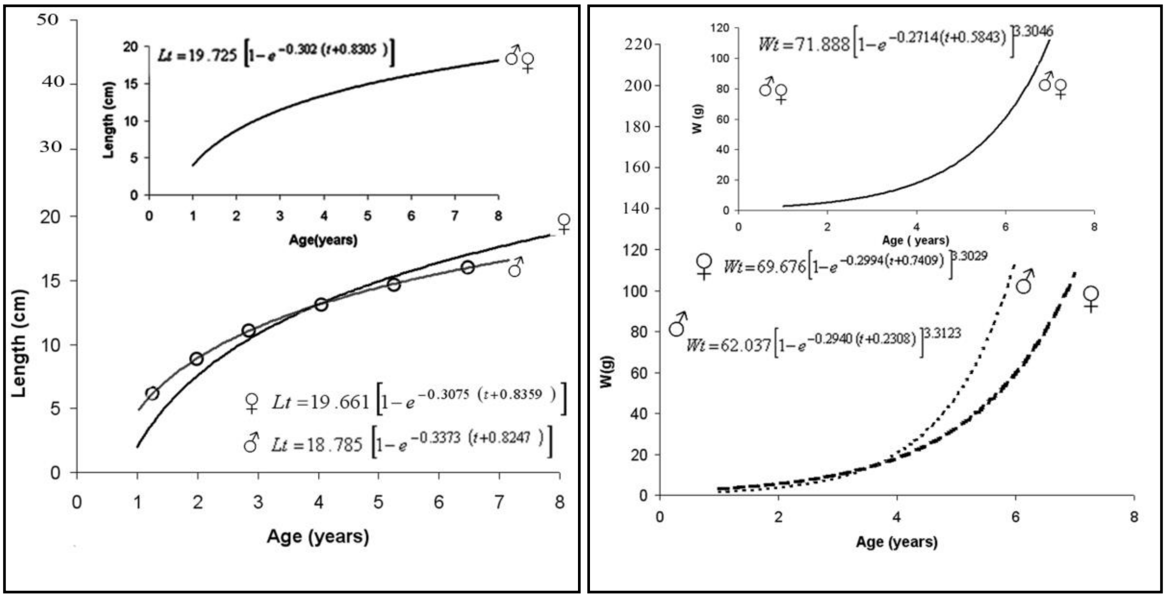
Reproduction ground and migration

Wintering ground and migration

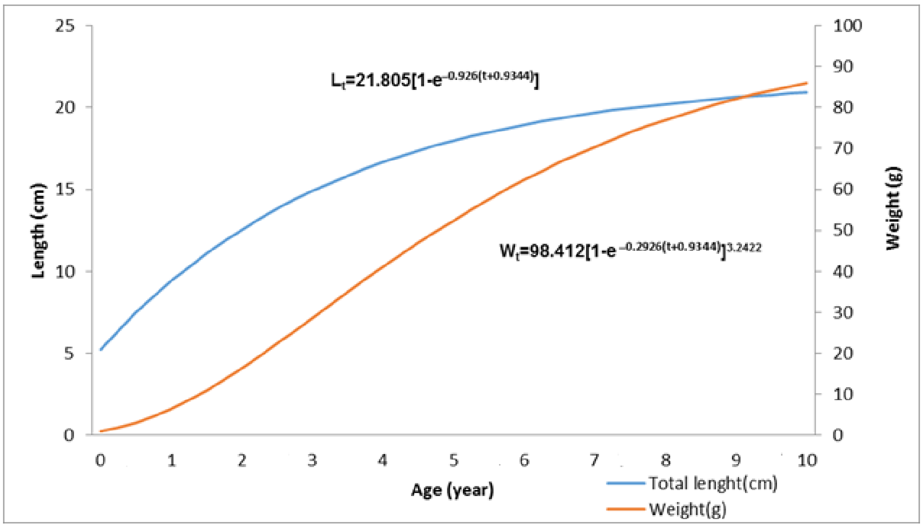
Figure 5.2.5.1.1. Distribution and migration routes of horse mackerel in the Black Sea.

5.2.5.2 Growth

Horse mackerel growth parameters from VBGF and length-weight relationship, provided by different countries are presented in Table 5.2.5.2.1. The exponent b, exhibiting positive allometric growth and there was not a significant difference between sexes (Yankova et al., 2010; Yankova, 2013a; Yankova, 2013b Yankova, 2013c; Yankova, 2014b).



A.



B.

Figure 5.2.5.2.1. Horse mackerel in GSA 29. Length-weight growth curves of males, females and both sexes combined from Bulgarian Black Sea waters (A-after Yankova et al., 2010; B- after Genç et al., 2015).

During the first 3 years of their life females and males differ in length (Figs. 5.2.5.2.1 A). Males are characterized by higher growth rates than females (Yankova et al., 2010). In the Turkish Black Sea, the asymptotic length of *T. mediterrenaus* varied from 18.50 to 26.09 cm and it was very different from that estimated by Kayalı (1998 – Linf=38.95cm) (Figs. 5.2.5.2.1B).

Table 5.2.5.2.1. Horse mackerel in GSA 29. VBGF parameters.

COUNTRY	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b
Bulgaria	2007-2008	HMM	C	19.75	0.30	-0.83	0.004	3.305
Bulgaria	2007-2008	HMM	M	18.79	0.34	-0.83	0.003	3.312
Bulgaria	2007-2008	HMM	F	19.66	0.31	-0.84	0.004	3.303

Bulgaria	2013	HMM	C	20.98	0.28	-0.71	-	-
Bulgaria	2014	HMM	C	20.45	0.31	-0.81	0.020	3.242
Romania	2000	HMM	C	18.60	0.22	-1.43	0.038	2.355
Romania	2001	HMM	C	18.95	0.27	-0.63	0.047	2.350
Romania	2009	HMM	C	18.42	0.42	-0.41	0.045	2.347
Romania	2010	HMM	C	20.03	0.30	-0.47	0.011	2.907
Romania	2011	HMM	C	17.37	0.37	-0.45	0.010	2.910
Romania	2012	HMM	C	16.84	0.27	-1.81	0.011	2.883
Romania	2013	HMM	C	16.84	0.47	-1.11	0.018	2.677
Romania	2014	HMM	C	16.80	0.50	-1.11	0.009	2.961
Turkey	1991 – 1992	HMM	M	19.90	0.40	-1.02	0.011	3.180
Turkey	1991 – 1992	HMM	F	20.60	0.36	-1.11	0.008	2.993
Turkey *	2005	HMM	C	20.24	0.32	-1.60	0.008	2.998
Turkey *	2006	HMM	C	22.39	0.24	-1.93	0.006	3.099
Turkey *	2007	HMM	C	22.23	0.26	-1.83	0.009	2.984
Turkey *	2008	HMM	C	22.24	0.25	-1.80	0.007	3.102
Turkey *	2009	HMM	C	24.02	0.21	-2.08	0.006	3.102
Turkey *	2010	HMM	C	25.00	0.19	-2.11	0.005	3.165
Turkey *	2011	HMM	C	24.44	0.24	-1.77	0.006	3.140
Turkey *	2012	HMM	C	21.36	0.29	-1.84	0.006	2.883
Turkey *	2013	HMM	C	19.80	0.45	-0.82	0.005	3.186
Turkey *	2014	HMM	C	21.81	0.29	-0.93	0.005	3.242
Ukraine	2008	HMM	C	18.50	0.34	-0.66	-	-

*Data according “Purse seine fisheries monitoring project by Trabzon Central Fisheries Research Institute”

In the Turkish Black Sea waters length- weight relationship parameters of a and b were calculated as 0.0045 and 3.2422 (Rsq= 0.98) respectively, for the whole sub-sampling (n=5187) in 2014 (Figure 5.2.5.2.2).

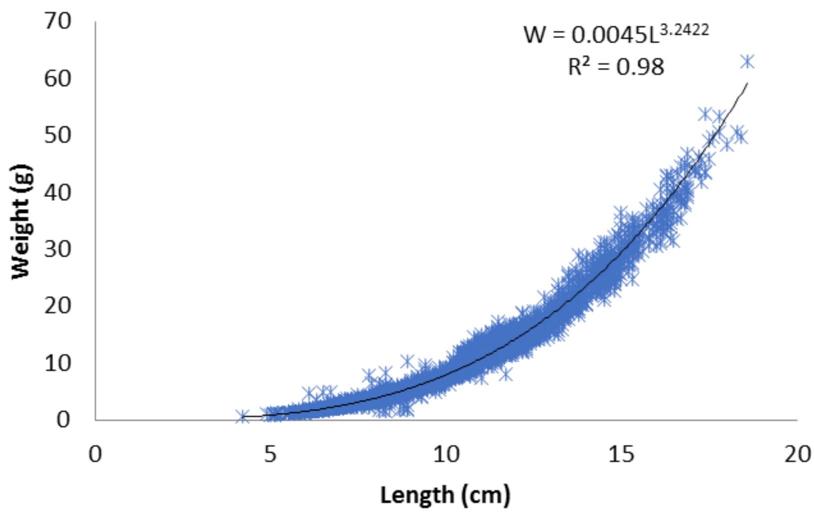


Figure 5.2.5.2.2. Horse mackerel in GSA 29. Length-weight relationship (Genç et al., 2015).

In the Turkish waters (2014), the average length of horse mackerel was 9.1 cm and the average weight was found to be 7.60 g. The maximum size was 18.5 cm.

5.2.5.3 Maturity

Horse mackerel matures at the age of 1-2 years old during the summer, which is also the main feeding and growth season. It spawns in the upper layers, mainly in the open part of the sea as well as near the coast (Arkhipov, 1993). Eggs and larvae are often found in areas with a low productivity and higher salinity (Arkhipov, 1993). Daskalov (1999) has found that horse mackerel recruitment is related to divergence and increased productivity of the sea. Peak spawning in the Bulgarian Black Sea Coast falls between June-August (Georgiev et al., 1961; Georgiev and Kolarov, 1962; Georgiev et al., 1962; Stoyanov et al., 1963, Karapetkova and Zhivkov, 2006; Yankova and Raykov, 2009; Yankova, 2011; Yankova M., 2014a). Spawning has been reported to occur 20 miles off the coast (Georgiev et al., 1962). The pelagic eggs are 0.73-1.00 mm (Georgiev et al., 1961; Georgiev et al., 1962; Stoyanov et al., 1963) and hatch after four days (Radu and Radu, 2008) at local temperatures 16-26 °C and salinity is 15.5-19‰ (Georgiev et al., 1961; Georgiev et al., 1962; Stoyanov et al., 1963). The eggs of horse mackerel are pelagic, spherical, with an oily globule (Karapetkova and Zhivkov, 2006). Horse mackerel reproduction start at the age of 1 year during the summer in Southern Black Sea (peak July), reproduction temperature is between 18-25 °C, salinity is 16-18 ‰ (Genç et al., 1999).

5.2.5.4 Natural mortality

Natural mortality has ranged between 0.2 and 0.6 year^{-1}. Turkey has reported value of natural mortality M= 0.23 year^{-1} (Genç et al. 1998), M= 0.51 year^{-1} (Atılgan 2012) and in 2014 0.539 year^{-1} (Genç et al. 2015). The same species may have different natural mortality rates in different areas depending on the density of predators and competitors, whose abundance is influenced by fishing activities (Sparre and Venema 1998). Even small changes in the growth parameters used could seriously affect the computed mortality rates (Tserpes and Tsimenidis 2001). EWG 15 12 prefer to use a constant natural mortality value (0.4) for assessments.

5.2.5.5 Fisheries

5.2.5.5.1 General description of the fisheries

The catches of Black sea horse mackerel were realized by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets) (Prodanov et al., 1997; Yankova et al., 2010a). The Bulgarian and Romanian catches are taken primarily by passive, while the Turkish and former USSR entities by active gears (Prodanov et al., 1997). The horse mackerel of age 1-3 years generally prevails in the commercial catches (Grishin et al., 2007; Yankova and Raykov, 2009; Yankova et al., 2010a), but strong year classes (for example, the 1969 year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years (Grishin et al., 2007).

State of the fisheries in Turkey

Horse mackerel stock was subject to overfishing, resulting in a fisheries collapse in the beginning of 1990’s (Ozekinei et al., 2001). The ratios of the undersize fish of horse mackerel (< 13 cm) for the seasons of spring, autumn and winter were calculated as 93.7, 75.8 and 30.7%, respectively (Dincer et al., 2007). Production of the horse mackerel, which is the second most important pelagic catch along Turkey's Black Sea coasts after the European anchovy, steadily increased until the mid-1980s and reached its maximum level of approximately 100,000 tons in 1985. The total amount of catch, however, constantly declined due to uncontrolled fishing activities and over-fishing in the 1990s and declined to 80,000 tons. Research into commercial fish stocks on Turkey's Black Sea coasts conducted during the second half of the 1980s indicated that the horse mackerel population suffered the

greatest fall in terms of quantity after the sea-perch among the pelagic stocks in the past 15 years (Bingel et al., 1995; Zengin et al., 1998a; Zengin, 2001). The breakdown of horse mackerel caught by commercial fishermen between 1991 and 1993, when the amount of horse mackerel catch started to decrease along Turkish coasts, by length confirms this conclusion. The average lengths of horse mackerel caught by large purse-seine nets and trawlers during those years were 11.1 cm, 10.9 cm and 10.6 cm, respectively (Zengin, 1998). Average exploitation rate (E) calculated for the same period was 0.78 (Genç et al., 1999), which clearly demonstrates the over-fishing of the horse mackerel stock. This sharp fall in the horse mackerel catch steadily increased until the end of the 1990s. The length of the horse mackerel population off the southern Black Sea coast after they reach initial reproductive maturity is 11.7 cm (Genç et al., 1999).
After the beginning of the 2000s the landings started to increase again. Total Turkish Black sea catch was up to 26.000 tons (2006 official statistics) and the average length also increased 13.7 cm. (Genç et al, 2006). In the Black Sea coast of Turkey, horse mackerel production was 18979.4 tons in 2013, which covered 9% of the total fish landings in the same marine area. Horse mackerel stocks are usually caught by Turkish fishermen using active (purse seine, bottom trawler, pelagic trawler) and passive (gillnet and longline) nets (Table 5.2.5.5.1.2). A large part of the catch is caught in the autumn/early winter (September-December). The length of purse seine and trawl vessels is between 12-64m and small vessels are <12m. Some trawlers (particularly Samsun Shelf Area) are using to catch anchovy, sprat and horse mackerel. Almost the whole horse mackerel catch is obtained by purse seine in all fishing seasons. Horse mackerel isn't the primary target species in the large-scale purse seiners when bonito, bluefish and anchovy are available. However, when the amounts of these species are low, these vessels are targeting horse mackerel.

Operations of purse seine for horse mackerel is done often in coastal areas (<4 nm). Purse seine vessels can operate around the clock but especially during daytime. Fishing time is 9-10 hours, number of purse seine operations can be from 1 to 4 per day. In 2014, amount of horse mackerel catch was from 20 to 750 boxes (Mean box weight is 12-14 kg). According to common knowledge, this species is coming from Ukrainian or Georgian coasts to Turkish coasts and, later continues its migration. 0+ age group and large-scale schools in the same cohorts were found in the last two years (Ak and Dağtekin 2014).

State of the fisheries in Ukraine

After a long absence, by the end of 2002 fishing for horse mackerel was re-initiated in the waters under the jurisdiction of Ukraine. Horse mackerel forms aggregations during wintering and to a lesser extent, in autumn on their migration routes. The Ukrainian waters near the Southern coast of Crimea from November to March comprise the wintering ground of horse mackerel. In the formation of wintering aggregations of horse mackerel they can be captured by lifting cone-shaped nets with electric light attraction, and purse seines. In the warm season in small quantities horse mackerel are harvested with pound nets, including the Sea of Azov. In recent years the catch of horse mackerel in midwater trawl is taken as a by-catch in sprat fisheries. Generally, the share of Ukrainian total catch in the catch of mackerel in the Black Sea is very low.

Upon a characterization of commercial use of the Horse mackerel stock in Ukraine, two periods clearly stand out: 1992-2001 and 2003 up to the present. During the first of mentioned periods Horse mackerel was practically absent in Ukrainian fisheries Absence of commercial catches in the waters of the Black Sea under Ukrainian jurisdiction during 1992-2001 has an explanation in the considerable decrease of its stock numbers, which, in V. A. Shlyakhov and A. N. Grishin’s opinion (2009), was conditioned by the negative influence of Ctenophora *Mnemiopsis*. As these authors point, the introduction of Ctenophora *Beroe*, that had led to a decrease of negative influence of *Mnemiopsis*, has influenced positively the Horse mackerel stock state. Since 2003 it regained its commercial significance, and Ukrainian catches vary on the level of several thousand tons.

Horse mackerel forms aggregations during wintering and, to lesser extent, in the autumn on migration routes. It winters in Ukrainian waters near the Southern coast of Crimea from November to March, and some years can be found from c. Takil to c. Lucull. Upon forming wintering aggregations the possibility of specialized fishing of Horse mackerel with lifting cone-shaped nets with electric light attraction appears, and to lesser extent, of fishing with purse seines. But the aggregations of commercial character form not every year, thus the specialized fishing of Horse mackerel is carried out occasionally and only in certain years. As a rule, the most part of Horse mackerel is caught with midwater trawls as by-catch at sprat fishing. During warm seasons Horse mackerel is caught with pound nets in small amounts. Under mentioned peculiarities of distribution, the prevalent part of the Horse mackerel year catch falls on I and IV quarters.

5.2.5.4.2 Management regulations applicable in 2015

Turkey

The Ministry of Food, Agriculture and Livestock is the main state organisation responsible for fisheries administration, regulation, protection, promotion and technical assistance through four General Directorates. All activities in fisheries and aquaculture are based on the Fisheries Law No. 1380, enacted in 1971. Under this law, and its related bureaucracy, definitions were codified. Based on this law, regulations, circulars and notifications are drafted to regulate fisheries. This arrangement was followed by new management criteria brought into force for horse mackerel fishery (Ak and Dağtekin, 2014). These measures cover (Notification:2012/65):

i. Minimum catch size: 13 cm total length. Only 15% on weight based undersized fish permitted in the landing.
ii. Fishing area: There are no restrictions for fishing areas.
iii. Fishing gear: Fishing is allowed for purse seiners, trawlers, gillnet and long liners.
iv. Time periods: Pelagic fishing period starts on 1 September and lasts up to 15 April,with bottom trawling allowed between 15 September and 15 April. Pelagic trawl fishing period is between 15 September and 15 May. However, pelagic trawl is permitted only for sprat fisheries between 15 April and 15 May. Also gillnet can be used during the whole year. Horse mackerel fishing can be conducted throughout the day.
v. Depth: The pelagic fishery is banned in waters shallower than 24 m in all seasons.
vi. Others: Small pelagics have to be carried in cases or boxes with a net weight of 12 kg (± 10%). Certificate of origin and transportation is obligatory. Fisheries cooperatives are authorized for the issuing of this document.

Bulgaria

The commercial fishery is forbidden with all kind of gears in the following zones:

i. the zone from Cape Siviburun to the mouth of Cape Emine in 3 mile zone;
ii. in zone, restricted by the coastal line till the line “Emine – Nessebar”;
iii. in zone restricted by the coastal line till the line “Nessebar” – Chernomoretz, South Cape.

iv. from village Chernomoretz, South Cape till the mouth of Rezovska River in the one mile zone;
v. the closed for fishery zones are free for fishery with pelagic trawls in the period of 15 August to 15 September for catching migrating schooling species. In the presence of by catch of the individuals from species under quota, after the quota exhausting, all the individuals should be returned in the water, no matter what is their condition.
vi. minimum admissible length for HMM is 12 cm total length;

Romania

In the economic fishing activity, it is banned to use:

i. the trawl in marine zone under the 20 m depths;
ii. gear type of dredge and bottom trawl in the Black Sea;
iii. It is banned to utilize the fishing gears with minimum mesh size smaller then: a = 7 mm, 2a = 14 mm respectively, at the trawl in the Black Sea;
iv. minimum dimensions of the fish in centimeters and other living aquatic resources able to be fished are regulated by Order no. 342/2008 on minimal size of the aquatic living resources;
v. minimum admissible length for HMM is 12 cm total length;

Ukraine

i. TAC – no;
ii. minimum catch size – 10 cm (Standard length);
iii. allowable percentage by-catch of smaller fishes – 20%;

5.2.5.5.2 Catches

No information has been available during the EWG 15-12 meeting.

5.2.5.5.3 Landings

The data set of landings was compiled for the period 1950-2014. It is evident (Table 5.2.5.5.3.1) that during the periods (1956 – 1965) the catches have continued to grow and their mean values reached 19007. 95 tons. During the period 1966 – 1975 the total average catch have increased to 21041.98 tons. The next decade (1976-1985) the horse mackerel catches have also increased from 20576.3 to 141077.8 tons, respectively. The period 1986 – 1995 was characterized by an abrupt decline in the catches from 977408 to 15906 tons. The next 7 years (1996 – 2002) represented a period of prolonged decrease of the horse mackerel catch; mean values reached 12343.64 tons.
The data of Bulgarian catches show considerable fluctuations (Yankova et al., 2009). The last investigated years are characterized by a trend of considerable increase of horse mackerel catches. Following 2007 a substantial increase (around 55%) was reported in catches of horse mackerel;the amount was 179.8 t for 2008 (data source -official statistics of the National Agency of Fisheries and Aquaculture).

Table 5.2.5.5.3.1. Horse mackerel in GSA 29. Landings (in tonnes) by countries during the period 1950-2014. Catches taken in Crimea in 2014 are included in the Ukranian catches.

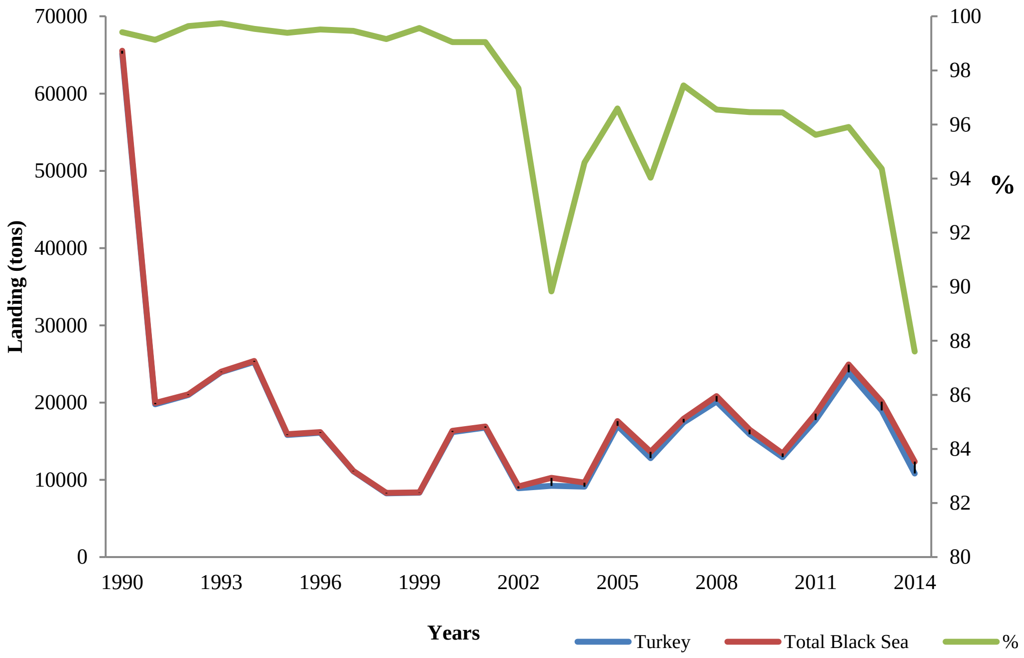
Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1950	644	-	217	-	1200	-	8291

1951	736	-	293	-	2500	-	5399
1952	565	-	260	-	2600	-	6475
1953	295	-	141	-	9200	-	22095
1954	593	-	618	-	12200	-	25511
1955	662	-	297	-	7200	-	19950
1956	132	-	64	-	14200	-	29735
1957	69	-	120	-	14000	-	26919
1958	233	-	587	-	4900	-	17370
1959	687	-	840	-	700	-	12687
1960	1018	-	675	-	4800	-	17692
1961	1241	-	2200	-	3600	-	16346
1962	805	-	1166	-	13500	-	29271
1963	231	-	532	-	3500	-	18163
1964	242	-	248	-	3100	-	13790
1965	302	-	1365	-	1200	-	8106
1966	557	-	1770	-	600	-	5277
1967	246	-	762	-	24615	-	32112
1968	37	-	175	-	4750	-	20124
1969	96	-	156	-	16762	-	18294
1970	689	-	1342	-	19380	-	22041
1971	631	-	1218	-	8722	-	14921
1972	534	-	500	-	10855	-	33709
1973	849	-	606	-	16594	-	28829
1974	2169	-	608	-	10245	-	15905
1975	1973	-	1003	-	11898	-	19209
1976	1809	-	1514	-	14078	-	35746
1977	791	-	404	-	14674	-	20576
1978	565	-	729	-	23529	-	25508
1979	935	-	1179	-	59772	-	62620
1980	813	-	1536	-	42339	-	45297
1981	476	-	588	-	40543	-	41951
1982	367	-	291	-	48918	-	51451
1983	497	-	1510	-	54548	-	63712
1984	1016	-	872	-	69980	-	77370
1985	756	-	1035	-	100417	-	141078
1986	851	-	945	-	100943	-	105109
1987	826	-	997	-	90850	-	93216
1988	1677	-	2660	-	93006	-	977408
1989	1101	-	1459	-	94023	-	96888

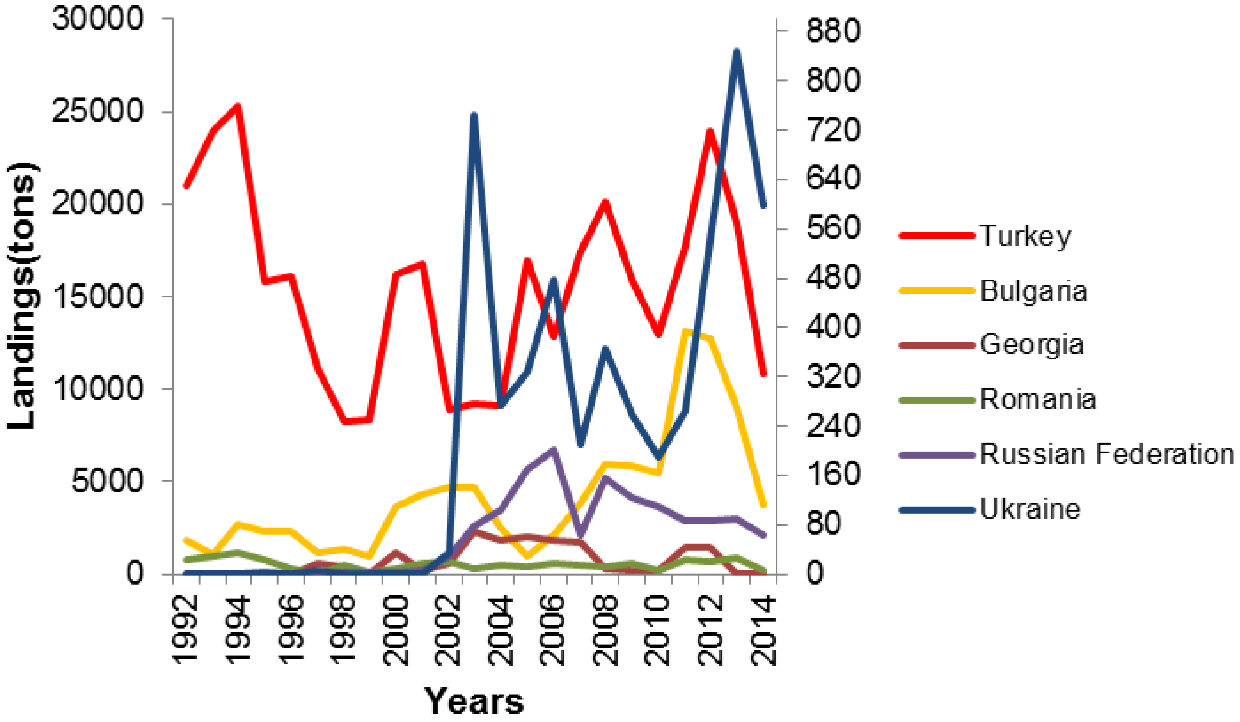
1990	164	-	165	-	65163	-	65548
1991	123	48	0	-	19781	-	19955
1992	54	0	22	0	20989	0	21065
1993	31	0	30	0	23945	0	24006
1994	80	0	35	1	25275	1	25392
1995	70	0	24	1	15809	2	15906
1996	68	0	10	0	16093	0	16171
1997	36	18	1	0	11097	5	11157
1998	40	13	15	2	8246	0	8316
1999	30	0	3	2	8331	1	8367
2000	111	35	8	2	16181	0	16337
2001	130	7	17	6	16750	1	16911
2002	142	19	21	28	8903	34	9147
2003	142	70	10	77	9213	745	10257
2004	74	56	14	105	9113	272	9634
2005	29	60	12	169	17003	329	17602
2006	63	55	19	201	12812	476	13625
2007	116	53	14	63	17429	211	17886
2008	180	8	11	154	20124	366	20843
2009	177	6*	17	124	15905	260	16489
2010	165	5*	7	109	12929	190	13406
2011	395	44**	23	87	17746	264	18559
2012	381	44	20	70	23911	540	24931
2013	271	0	26	89	18979	847	20114
2014	113	750***	7	65	10825	597	12357

* expert assessments;
** oral announcement in meeting AG FOMLR/BSCommission 2011.
***Turkish experts consider that horse mackerel catch is around 500 t minimum (according to observation on by catch rates in anchovy per seine nets), on the other hand Ukrainian expert has unofficial information about the total landing of horse mackerel for 2014 as 1000 t. As a result experts conclude on to use 750t taking into consideration these two numbers.

About 90% of the total horse mackerel catch was made by Turkey in the Black Sea. In the 2014 fishing season the catches of horse mackerel in Turkey decreased by 43% compared to the previous year. Therefore, Turkey's share of total production in the Black Sea in 2014 declined to 87% level (Figure 5.2.5.5.3.1A-B).



A.



B.

Figure 5.2.5.5.3.1. Horse mackerel in GSA 29. Trend in total (A) and by countries (B) landings in the Black Sea.

5.2.5.5.4 Discards

No discards have been reported for the horse mackerel fishery.

5.2.5.5.5 Fishing effort

Most of horse mackerel fishing (90%) in the Black Sea is done by Turkey. Therefore, Turkey is decisive in the horse mackerel fishing in the Black Sea. Most of the fishing in Turkey is done by purse seiners. Changes of fishing effort in Turkey according to the years are given below (Table 5.2.5.5.5.1). In 2014, depending on the increase in the catch of bonito and bluefish; fishing effort for horse mackerel has decreased. In the next period from January, depending on the distribution of the horse mackerel in the coast of Turkey, there has been a decrease in the number of fishing days.

Table 5.2.5.5.5.1. Changes in fishing effort in Turkey.

Year	N vessels	kW*days	Hours fished
1996	278	9484671	100080
1997	248	9484671	89280
1998	209	9484671	75240
1999	199	9030859	71640
2000	262	11889874	94320
2001	220	9983864	79200
2002	136	6171843	48960
2003	145	7160274	52200
2004	138	6814606	49680
2005	232	11456438	83520
2006	199	9826859	71640
2007	164	8098517	59040
2008	192	9481190	69120
2009	160	7900992	57600
2010	168	8296042	60480
2011	195	9629334	70200
2012	181	8937997	65160
2013	197	9135522	70920
2014	195	7222001	52650

5.2.5.6 Scientific surveys

No specific fisheries independent scientific surveys have been conducted.

5.2.5.7 Stock Assessment

5.2.5.7.1 Methods

Given the availability of a tuning fleet of commercial CPUE from Turkey for years 2005-2014 an XSA (Extended Survivors Analysis (XSA, Shepherd, 1992) was conducted.

5.2.5.7.2 Input data

XSA analysis was performed using 2005-2014 data using catch at age data provided by countries. No available data for age-weight length key for Ukraine, Russian Federation and Georgia for 2014. EWG 15 12 decided to use Turkish key for Russian Federation, Ukraine and Georgia.

In the analysis of all data about the size and age composition available for the experts certain differences between the data obtained from the Ukraine, Russian Federation and Georgia were revealed. Due to lower mean weight (11.15 g) of the data for Turkey and the fact that the above mentioned countries have higher mean values than Turkey, EWG 15 12 prefer to use their mean weight values performed in 2013 in order to calculate weight of fish landed in each age group.

A constant natural mortality value (0.4) was assumed. In the following section the input data for the XSA are reported. A first step taken was to correct the catch at age data to the official landings (SOP corrections) since there where clear discrepancies. The XSA was tuned with an index based on commercial CPUE data from a Turkish fleet, which is considered reliable and is deemed appropriate for tuning the bulk of the catches coming from the Turkish series but with some limitations. Data from 2004 were discarded since they covered only the first 4 age classes and age 3 presented large catches (similarly to the assessment done in EWG 14-14).

Table 5.2.5.7.2.1. Horse mackerel in GSA 29. Aggregated catch at age in number (10^3) of Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine during the period 2005-2014 used in XSA.

Age Year	0	1	2	3	4	5	6
2005	24623.8	446026.4	510230.8	117165.3	15977.1	2078.6	54.3
2006	7149.7	289385.0	381781.8	68877.6	19612.5	2295.0	554.5
2007	596.9	633607.8	364748.2	61099.8	5731.8	2740.4	0.1
2008	6678.3	189996.6	556876.1	232242.6	27287.2	2573.9	26.6
2009	3910.7	395249.7	421199.3	92146.0	37179.5	6013.3	998.4
2010	28029.2	300248.2	334444.6	128585.4	55875.0	18165.2	6057.4
2011	29325.5	715934.2	272264.8	134564.1	23781.8	7464.8	3072.3
2012	20740.4	692428.0	633694.9	55724.2	6778.7	1088.4	88.0
2013	380709.3	961880.3	326623.8	36617.1	2768.8	1399.8	44.8
2014	766523.2	651769.3	62641.8	4261.1	1267.4	930.4	85.5

Table 5.2.5.7.2.2. Horse mackerel in GSA 29. Mean weights at age used in the XSA (both in catch and stock).

Age Age	0	1	2	3	4	5	6
2005	0.00424	0.01323	0.02062	0.02972	0.03862	0.04584	0.04356
2006	0.00494	0.01377	0.02119	0.02934	0.04206	0.05182	0.05720
2007	0.00966	0.01470	0.02010	0.02919	0.03697	0.04272	0.05494
2008	0.00479	0.01266	0.02307	0.03028	0.03900	0.05090	0.04125

2009	0.00519	0.01301	0.02069	0.03022	0.04254	0.05012	0.06744
2010	0.00437	0.01005	0.02185	0.02846	0.03143	0.03681	0.06336
2011	0.00543	0.01301	0.02479	0.03789	0.05142	0.06563	0.07317
2012	0.00652	0.01439	0.02318	0.03349	0.03462	0.04941	0.03988
2013	0.00350	0.01189	0.02360	0.03245	0.03321	0.04395	0.06297
2014	0.00350	0.01018	0.02575	0.03785	0.03454	0.03634	0.04564

A tuning series from a commercial CPUE from Turkey has been used to tune an XSA model. Each age group catch was split into the total landings. Rate in each age group were divided by the CPUE. Resulting value was multiplied by the weight in each age group. Each age group was divided by the total weight. Resulting values were multiplied by the CPUE. It is seen that CPUE is high between 1 and 3 age groups (Table 5.2.5.7.2.3).

Similarly to the assessment done in EWG 14-14, data from 2004 were discarded since covered only the first 4 ages and age 3 presented large catches.

Table 5.2.5.7.2.3. Horse mackerel in GSA 29. CPUE indices from purse seine Turkish fleet used in XSA.

Age Year	0	1	2	3	4	5	6
2004	5.750	16.712	56.703	1571.740	0.001	0.001	0.001
2005	9.502	526.523	932.523	305.137	50.317	8.218	0.001
2006	3.821	402.208	896.453	199.775	91.040	12.706	3.545
2007	0.130	1337.120	1054.302	233.291	24.878	7.139	0.001
2008	3.440	264.512	1428.759	795.583	115.930	12.088	0.001
2009	2.375	711.841	1200.634	340.883	187.074	33.301	9.049
2010	14.074	351.141	848.592	417.379	181.883	65.929	44.960
2011	13.988	913.577	662.271	497.828	116.348	48.617	22.498
2012	4.869	1268.245	1811.319	199.510	13.323	5.385	0.001
2013	168.115	1310.860	845.355	77.952	4.351	1.920	0.001
2014	446.469	1113.157	265.274	23.825	1.367	0.261	0.059

Table 5.2.5.7.2.4. Horse mackerel in GSA 29. Proportion of matures at age used in XSA.

Age Year	0	1	2	3	4	5	6
2005	0	0.8	1	1	1	1	1
2006	0	0.8	1	1	1	1	1
2007	0	0.8	1	1	1	1	1
2008	0	0.8	1	1	1	1	1
2009	0	0.8	1	1	1	1	1
2010	0	0.8	1	1	1	1	1
2011	0	0.8	1	1	1	1	1
2012	0	0.8	1	1	1	1	1
2013	0	0.8	1	1	1	1	1
2014	0	0.8	1	1	1	1	1

Table 5.2.5.7.2.5. Horse mackerel in GSA 29. Natural mortality at age used in XSA.

Age Year	0	1	2	3	4	5	6
2005	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2007	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2008	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2009	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2010	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2012	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2013	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2014	0.4	0.4	0.4	0.4	0.4	0.4	0.4

5.2.5.7.3 Results

XSA was settled with different shrinkage values (Sh1.0, Sh1.5, Sh2.0). As showed by Figure 5.2.5.7.3.1, the different settings produced similar estimates of recruitment and SSB.

Comparison of different shrinkage values and relative residuals diagnostics

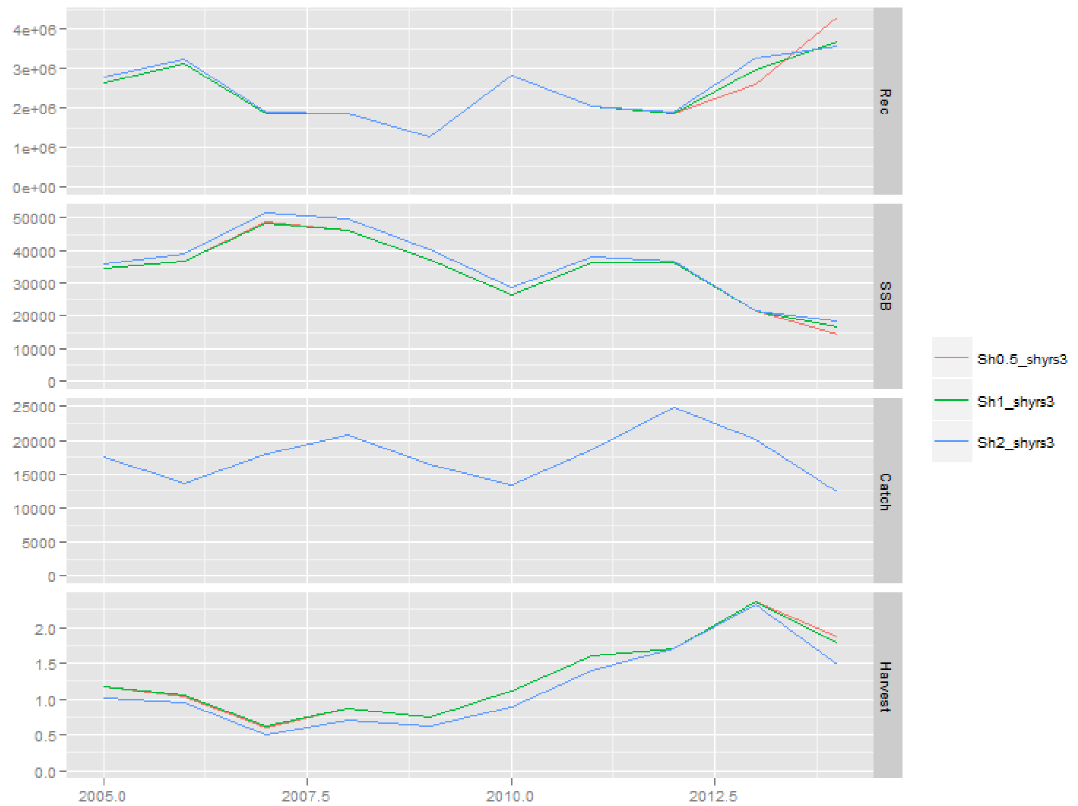


Figure 5.2.5.7.3.1. Horse mackerel in GSA 29. XSA outputs for different shrinkage scenario.

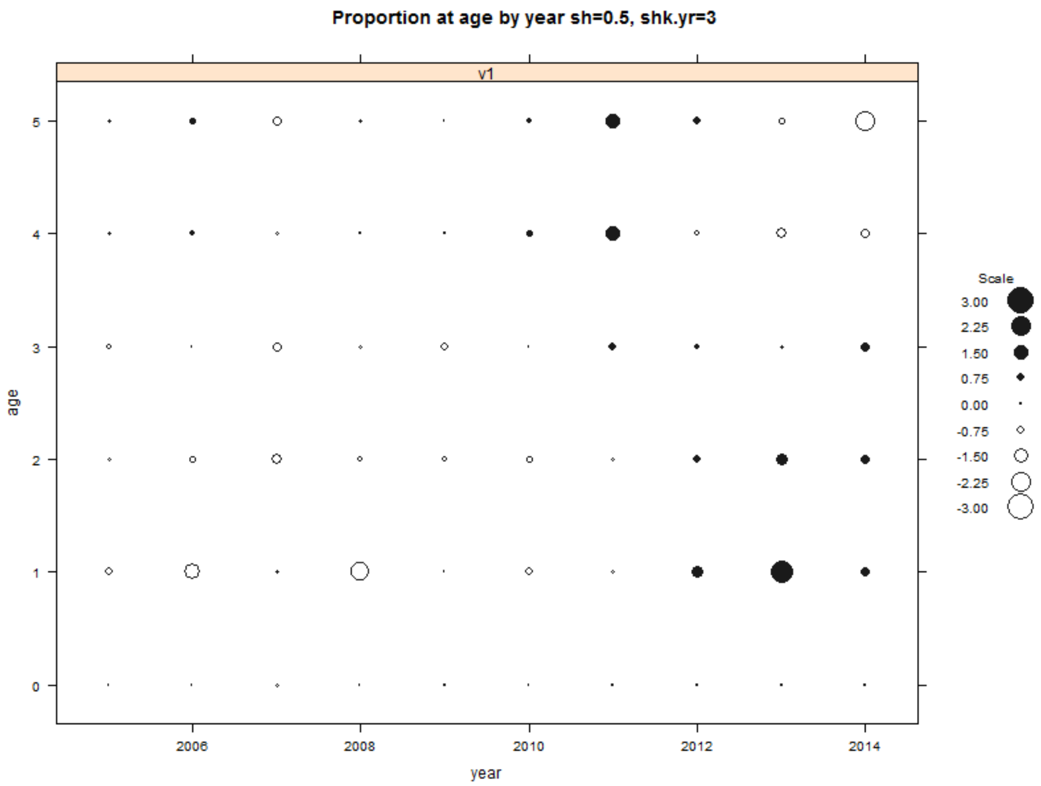


Figure 5.2.5.7.3.2. Horse mackerel in GSA 29. Log residuals for the tuning fleet (Shrinkage=0.5)

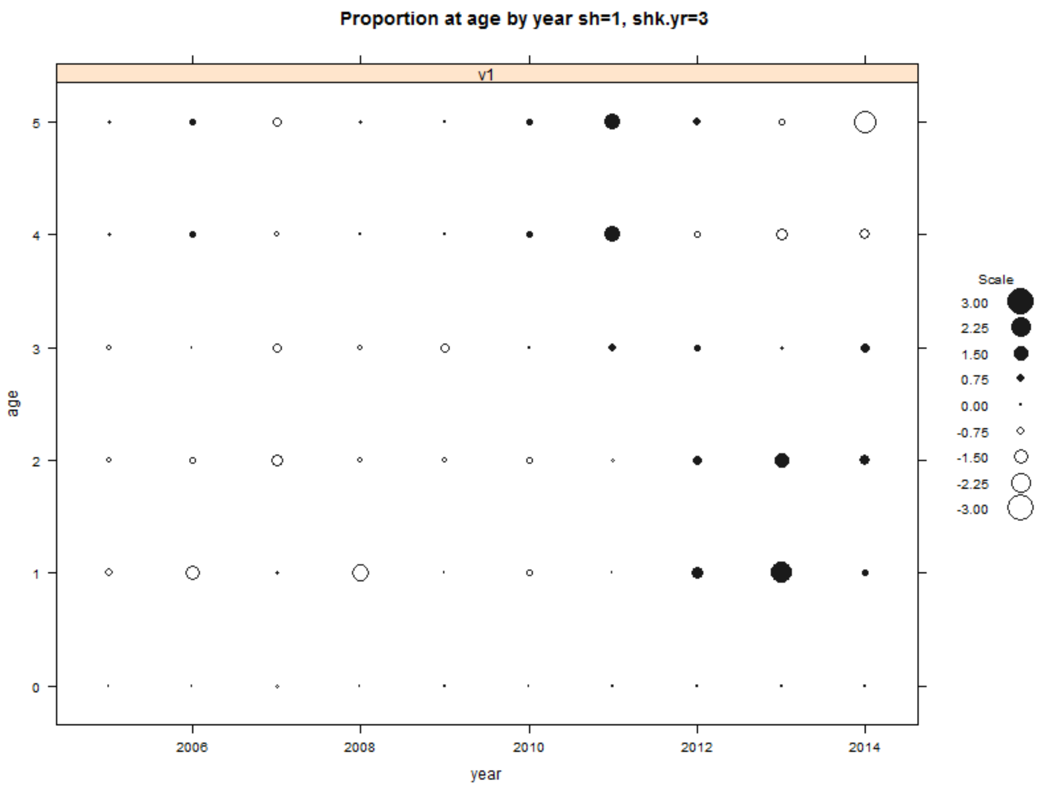


Figure 5.2.5.7.3.3. Horse mackerel in GSA 29. Log residuals for the tuning fleet (Shrinkage=1)

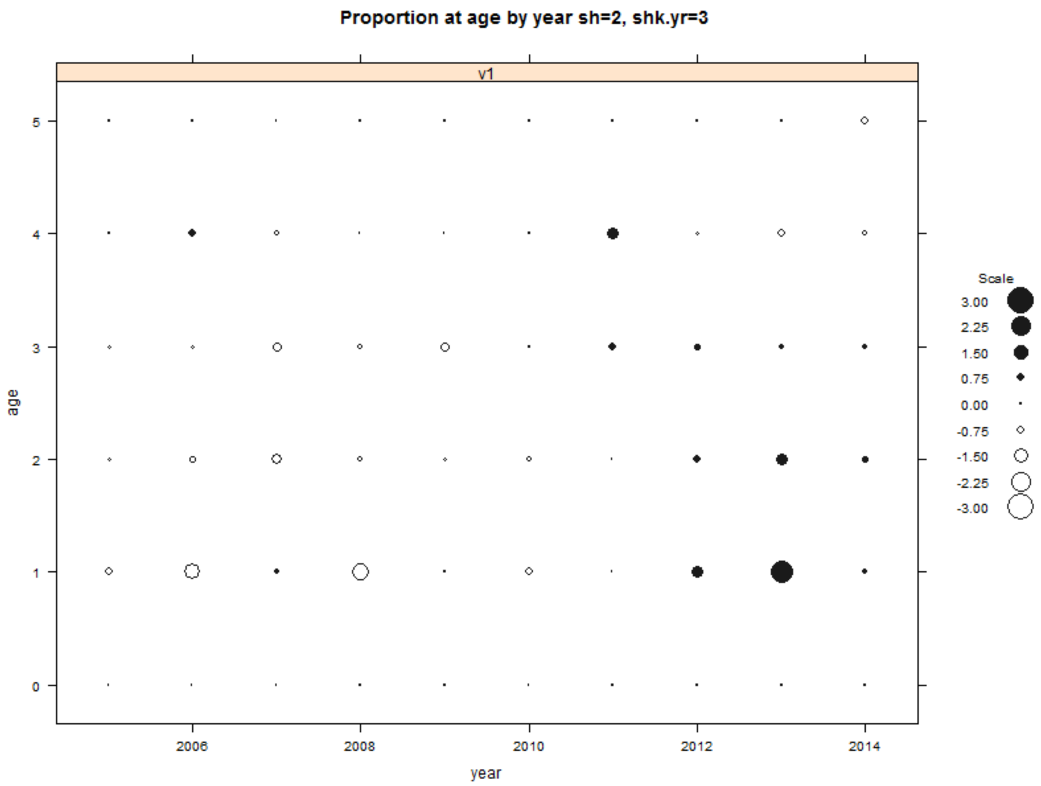


Figure 5.2.5.7.3.4. Horse mackerel in GSA 29. Log residuals for the tuning fleet (Shrinkage=2)

Model with 2.0 shrinkage was adopted as final model based on the analysis of residual distributions. Residuals from tuning fleets (Turkish CPUE) per age and year were relatively low, and did not show any trend with time.

Moreover a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 5.2.5.7.3.5) to ensure the robustness of the final estimates. The retrospective series indicate a moderate agreement between years in the assessment results, although SSB is generally overestimated and F is underestimated.

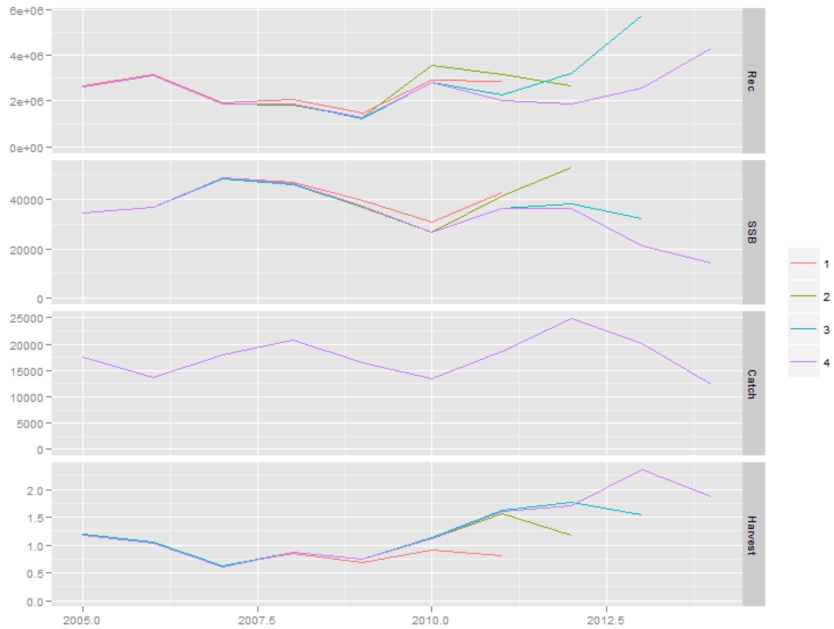


Figure 5.2.5.7.3.5. Horse mackerel in GSA 29. Retrospective analysis with shrinkage set at 0.5.

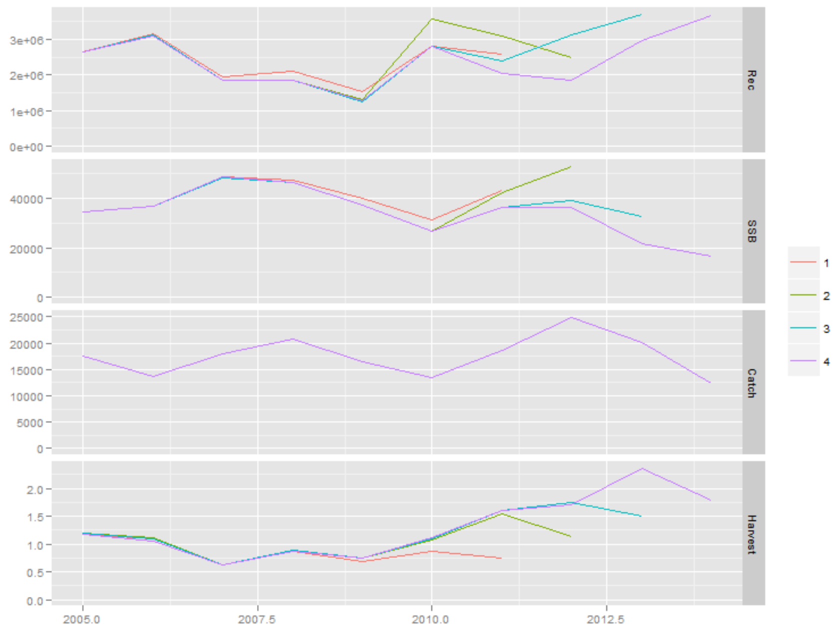


Figure 5.2.5.7.3.6. Horse mackerel in GSA 29. Retrospective analysis with shrinkage set at 1.

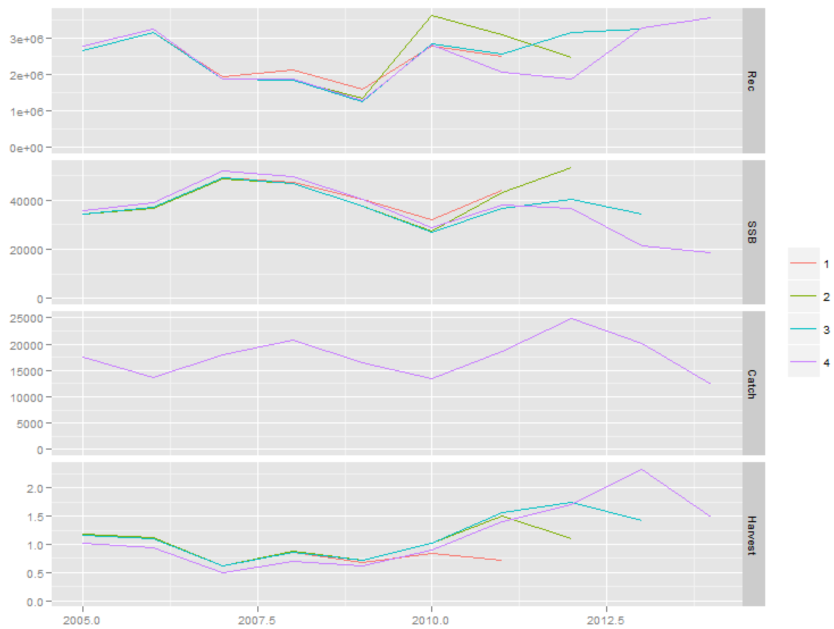


Figure 5.2.5.7.3.7. Horse mackerel in GSA 29. Retrospective analysis with shrinkage set at 2.

Based on these simulation analyses, the model settings reported in Table 5.2.5.7.3.1 were selected to run the final XSA.

Table 5.2.5.7.3.1. Horse mackerel in GSA 29. Inputs selected to run the final XSA.

fse	rage	qage	Shk.n	Shk.f	Shk.yrs	Shk.ages
2.0	1.0	6.0	true	true	3.0	2.0

XSA main outputs (Fig. 5.2.5.7.3.8) showed that F values ranged between 0.501 and 2.328. Recruitment is indicated to have decrease in the mid part of the series and is now in a high period. Assessment formulations indicate that the SSB in 2014 was lower compare to the previous year but is fluctuating since 2005 (Tab. 5.2.5.7.3.2.)

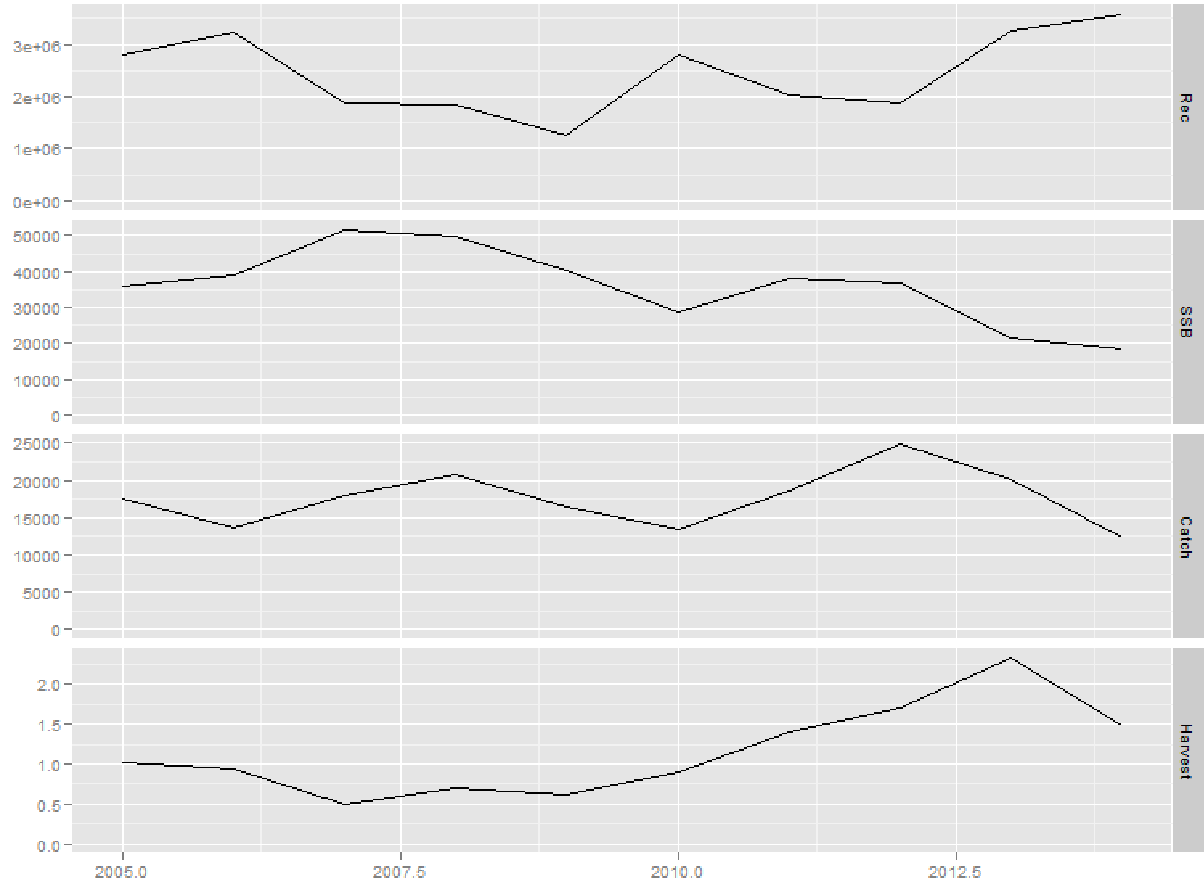


Figure 5.2.5.7.3.8. Horse mackerel in GSA 29. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

Table 5.2.5.7.3.2. Horse mackerel in GSA 29. XSA stock summary results.

SSB	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Tons	35692	39175	51765	49830	40292	28732	38165	36595	21581	18453
Rec	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
(x 1000)	2787396	3245500	1875879	1854231	1262632	2809300	2042320	1872851	3259745	3563851
Stock number	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	2787400	3245500	1875900	1854200	1262600	2809300	2042300	1872900	3259700	3563900
1	1447000	1851300	2170200	1257000	1238100	843530	1864900	1349900	1239700	1896400
2	682150	659780	1027300	960270	704680	543220	370620	782410	380310	101520
3	167160	102430	160340	403950	239530	166850	147130	70573	44436	7228
4	28195	30568	17796	59793	102220	93727	28413	10718	5095	2016
5	5412	7788	6007	7456	20276	41554	26573	3510	2050	1316
6+	138	1845	2	76	3302	13518	10750	278	62	110
F by	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014

age										
0	0.009	0.002	0.000	0.004	0.003	0.010	0.014	0.013	0.142	0.343
1	0.385	0.189	0.415	0.179	0.424	0.422	0.469	0.867	2.102	0.624
2	1.496	1.015	0.533	0.989	1.041	0.906	1.259	2.468	3.563	1.792
3	1.299	1.350	0.586	0.974	0.538	1.370	2.219	2.228	2.693	1.591
4	0.887	1.227	0.470	0.681	0.500	0.860	1.691	1.254	0.954	1.891
5	0.508	0.392	0.757	0.468	0.387	0.550	0.320	0.431	1.481	3.109
6+	0.508	0.392	0.757	0.468	0.387	0.550	0.320	0.431	1.481	3.109
Fbar	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
(1-4)	1.017	0.945	0.501	0.706	0.626	0.890	1.409	1.704	2.328	1.475
Ebar	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
(1-4)	0.718	0.703	0.556	0.638	0.610	0.690	0.779	0.810	0.853	0.787

The XSA diagnostics are reported below:

```
FLR XSA Diagnostics 2015-09-29 14:41:39

CPUE data from indices

Catch data for 10 years 2005 to 2014. Ages 0 to 6.

                fleet first age last age first year last year alpha beta
1 Commercial CPUE Turkey        0        5      2005      2014  <NA> <NA>

 Time series weights :
   Tapered time weighting applied
  Power =   3 over  20 years

 Catchability analysis :
    Catchability independent of size for ages >   1
    Catchability independent of age for ages >   5

 Terminal population estimation :
    Survivor estimates shrunk towards the mean F
   of the final   3 years or the  2 oldest ages.

   S.E. of the mean to which the estimates are shrunk =   2

   Minimum standard error for population
   estimates derived from each fleet =  0.3

   prior weighting not applied
```

Regression weights

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	0.009	0.002	0.000	0.004	0.003	0.010	0.014	0.013	0.142	0.343
1	0.385	0.189	0.415	0.179	0.424	0.422	0.469	0.867	2.102	0.624
2	1.496	1.015	0.533	0.989	1.041	0.906	1.259	2.468	3.563	1.792
3	1.299	1.350	0.586	0.974	0.538	1.370	2.219	2.228	2.693	1.591
4	0.887	1.227	0.470	0.681	0.500	0.860	1.691	1.254	0.954	1.891
5	0.508	0.392	0.757	0.468	0.387	0.550	0.320	0.431	1.481	3.109
6	0.508	0.392	0.757	0.468	0.387	0.550	0.320	0.431	1.481	3.109

XSA population number (Thousand)

year	0	1	2	3	4	5	6
2005	2787396	1447018	682153	167157	28195	5412	138
2006	3245500	1851323	659782	102427	30568	7788	1845
2007	1875879	2170244	1027281	160337	17796	6007	2
2008	1854231	1256973	960269	403945	59793	7456	76
2009	1262632	1238081	704684	239533	102222	20276	3302
2010	2809300	843531	543220	166851	93727	41554	13518
2011	2042320	1864944	370625	147133	28413	26573	10750
2012	1872851	1349851	782406	70573	10718	3510	278
2013	3259745	1239698	380315	44436	5095	2050	62
2014	3563851	1896350	101524	7228	2016	1315	110

Estimated population abundance at 1st Jan 2015

year	0	1	2	3	4	5	6
2015	0	1695386	681258	11326	987	205	40

Fleet: Commercial CPUE Turkey

Log catchability residuals.

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	-0.039	-0.114	-0.151	0.001	0.066	-0.023	0.045	0.015	0.062	0.092
1	-0.721	-1.649	0.330	-1.855	0.013	-0.668	-0.064	1.229	2.420	0.372
2	-0.245	-0.492	-1.013	-0.414	-0.253	-0.407	-0.096	0.768	1.274	0.551
3	-0.279	-0.187	-0.862	-0.365	-0.908	0.072	0.799	0.624	0.379	0.459
4	0.008	0.690	-0.445	-0.012	-0.160	0.079	1.241	-0.170	-0.695	-0.458

```
 5  0.069  0.083 -0.051  0.114  0.087  0.134  0.161  0.041  0.072 -0.667

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.214138427176879" "1.28897424263472"  "14.1307389773475"  "5.04223315864631"


 Terminal year survivor and F summaries:

 ,Age 0 Year class =2014

source
                      scaledWts survivors yrcls
Commercial CPUE Turkey     0.204   2606768  2014
fshk                       0.016  11918161  2014
nshk                       0.780   1454816  2014

 ,Age 1 Year class =2013

source
                      scaledWts survivors yrcls
Commercial CPUE Turkey     0.622    909142  2013
fshk                       0.378    263371  2013

 ,Age 2 Year class =2012

source
                      scaledWts survivors yrcls
Commercial CPUE Turkey     0.552     19663  2012
fshk                       0.448      5060  2012

 ,Age 3 Year class =2011

source
                      scaledWts survivors yrcls
Commercial CPUE Turkey     0.668      1561  2011
fshk                       0.332       364  2011

 ,Age 4 Year class =2010

source
                      scaledWts survivors yrcls
Commercial CPUE Turkey     0.614       129  2010
fshk                       0.386       410  2010

 ,Age 5 Year class =2009
```

```
source
                  scaledWts survivors yrcls
Commercial CPUE Turkey     0.665       20  2009
fshk                  0.335      169  2009
```

5.2.5.8 Reference points

5.2.5.8.1 Methods

The Patterson Exploitation index (E=0.4) was selected as reference point consistent with long term exploitation of the stock.

5.2.5.9 Data quality

CPUE Turkish index had some limitations. First, the CPUE was an index of aggregated biomass split with the age structure of the catch matrix from Turkey; second, the yearly biomass index was derived by summing the monthly CPUEs rather than averaging across months. Finally, a commercial CPUE index derived from purse-seine catches and standardized to kg/vessel/day is a very raw index since it does not account of search time, number of sets, boat size etc. A much better index should be derived from fisheries independent surveys. Thus an international hydro-acoustic survey should be established to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of a dedicated hydro acoustic survey.

5.2.5.10 Short term predictions 2015-2017

No short term forecast was performed as the assessment is only indicative of trends.

5.2.5.11 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishingmortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of Horse mackerel in GSA 29 in 2016consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

Figure 5.2.5.11.1. Horse mackerel in GSA 29. Patterson Exploitation in relation to reference point E=0.4.

5.2.6 STOCK ASSESSMENT OF PIKED DOGFISH

5.2.6.1 Stock Identification

Piked dogfish are viviparous long-living fish inhabiting the whole Black Sea shelf at water temperatures between 6 and 15°C. They undertake extensive migrations: in autumn feeding migrations are aimed at grounds off Crimean Caucasus and Anatolian coasts characterized by wintering concentrations of anchovy and horse mackerel. After their disintegration, piked dogfish disperse all over the shelf. Reproductive migrations of piked dogfish take place towards the coastal shallow waters with two peaks of intensity: one in spring, and the most important one in autumn. The major grounds for reproduction of piked dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.

Off the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the intense spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba et al.. 1988). Juveniles are given birth in coastal zone at depth 10 – 30 m, at temperatures of 12 – 18°C (Maklakova, Taranenko, 1974). In autumn, piked dogfish aggregate into large schools, feeding on anchovy and horse mackerel, which migrate to wintering grounds along eastern and western coast. The densest concentrations of piked dogfish are observed in association with anchovy, sprat and whiting concentrations in the waters of Georgia and Turkey, in the waters of Ukraine and Romania (at depth from 70 m to 120 m) (Kirnosova, Lushnicova., 1990).

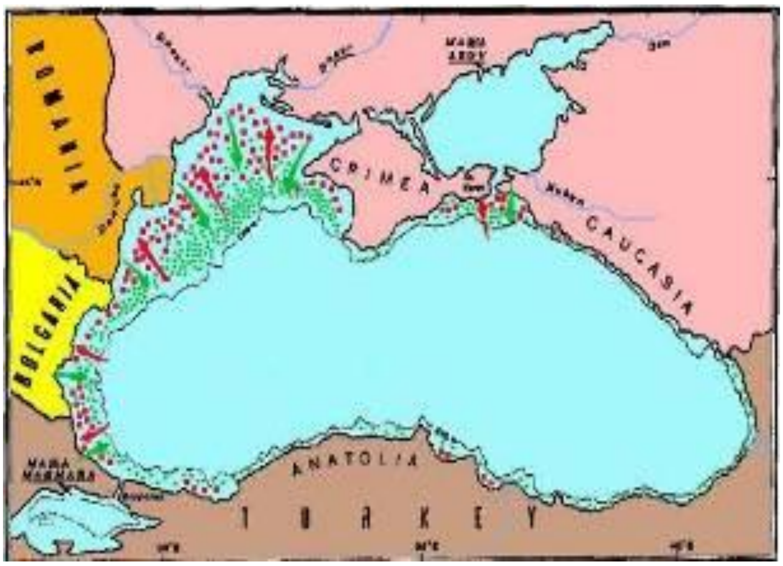


Fig. 5.2.6.1.1. Piked dogfish in GSA 29. Distribution and migration routes of the piked dogfish at Black Sea level (Radu et al.,2009b, 2010a).

5.2.6.2 Growth

Piked dogfish is a major demersal predator in the Black Sea, reaching a maximum length of 150 cm, and a maximum age of 20 years (Kirnosova, 1993).

Table 5.2.6.2.1. Piked dogfish in GSA 29. Growth parameters estimated in Romanian waters.

Parameters	2011	2012	2013	2014
L_{inf}	136	157	156	153
a	0.012	0.017	0.061	0.019
b	2.769	2.696	2.413	2.673
k	0.191	0.153	0.134	0.134
t_0	-1.310	-1.137	-0.930	-0.975

5.2.6.3 Maturity

Age and length at first maturity are 10 years and 87.5 cm for males, and 12 years and 103.0 cm for females, respectively. In conformity with Ukrainian data, the maturity vector for last years is the following:

Table 5.2.6.3.1. Piked dogfish in GSA 29. Maturity vector (Ukrainian data).

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.25	0.45	0.55	0.75	0.95	1.0	1.0	1.0	1.0	1.0

5.2.6.4 Natural mortality

For calculation of natural mortality (M) Poly's M empirical equation has been utilized:

$$\log(M) = -0.0066-0.279\log(L_{inf}) + 0.6543\log(k) =+ 0.4634\log(t)$$

Table 5.2.6.4.1. Piked dogfish in GSA 29. Natural mortality estimated in Romanian waters.

Parameters	2011	2012	2013	2014
M	0.258	0.150	0.220	0.228

5.2.6.5 Fisheries

5.2.6.5.1 General description of the fisheries

In the Black Sea the largest catches of piked dogfish are along the coasts of Turkey. Although they are not a target species, piked dogfish are a by-catch in trawl and purse seine fisheries, especially in winter. In 1989-1995, annual catches by Turkish fleet were 1055-4558 t (Shlyakhov, Daskalov, 2008), then they decreased about 2 times and did not exceed 2400 t. In Ukrainian waters, piked dogfish is harvested in spring and autumn by gill-nets, long-lines, and as by-catch of sprat trawl fisheries. As in Turkish waters, the largest annual catches of piked dogfish were observed in 1989-1995, reaching 1200-1300 t. In the other countries, piked dogfish is harvested mainly as by-catch, and annual catches are usually low. It should be noted that in the waters of Bulgaria, the highest catches were observed in the early 2000's. In Romania dogfish is caught mainly as by-catch of the sprat trawl fishery. The catches decreased sharply because of the decreasing fishing effort (Maximov et al., 2008b, 2010b; Radu et al., 2009b, 2010a,b). In the last years the importance of the catches in Bulgaria increased, these being around 40% of total Black sea catches.

5.2.6.5.2 Management regulations applicable in 2015

Only Romania has presented data on management regulations to EWG15-12. Romanian fisheries regulatory framework includes the following laws:

- Law on Fishing Fund. Fishery and Aquaculture No. 23 /2008;
- Annual Order on the Fishing Prohibition;
- Order no. 342/2008 on minimum size of the aquatic living resources;
- Order nr. 449/2008 on technical characteristics and practice conditions for fishing gears used in the commercial fishing.

In order to protect reproduction and recovery of the stock, the following measures were adopted (Radu and Nicolaev, 2010):

- 60 days fishing ban in April - June;
- it is banned to use the trawl in marine zone shallower than 20 m of depth;
- mesh size for dogfish gillnets: a = 100mm. 2a = 200 mm;
- minimum admissible length in catches is 120cm (TL)

In the Black Sea fishes IUCN list, *Squalus acanthias* is categorized (www.blacksea-commission.org) as follows:

Table 5.2.6.5.2.1. Piked dogfish in GSA 29. The IUCN status of piked dogfish in the Black Sea countries

Country	BG	GE	RO	RF	TR	UKR
IUCN status	N/A	LC	NT	N/A	EN	NT

LC - least concerned; NT- near threatened; EN- endangered; N/A – no data

5.2.6.5.3 Catches

For 2014, all Black Sea riparian countries reported the piked dogfish catches as landings.

5.2.6.5.4 Landings

The landings of Piked dogfish by countries are given in Table 5.2.6.5.4.1.

Table 5.2.6.5.4.1. Piked dogfish in GSA 29. Piked dogfish landings by countries (FAO Fisheries Statistics, GFCM Capture Production 2006 – 2008, BSC data, input from experts).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1989	28	217	30	135	4558	1191	6159
1990	16	128	45	183	1059	1330	2761
1991	21	18	26	67	2017	775	2924
1992	15	14	52	15	2220	595	2911
1993	12	131	6	5	1055	409	1618
1994	12	45	2	11	2432	148	2650
1995	80	31	7	90	1562	67	1837
1996	64	71	5	19	1748	44	1951
1997	40	1	5	9	1510	20	1585
1998	28	550	5	6	855	38	1482
1999	25	18	5	9	1478	94	1629

2000	102	21	5	12	2390	71	2601
2001	126	27	5	27	576	134	895
2002	100	65	5	19	316	97	602
2003	51	40	5	29	184	172	481
2004	47	31	5	34	211	93	421
2005	15	35	5	19	102	75	251
2006	6	10	9	17	193	67	302
2007	24	2	17	32	91	45	211
2008	23	0.4	10	59	35	79	206
2009	9	2	4	14	159	47	235
2010	42	2	3	9	16	27	98
2011	38	2	4	4	27	31	104
2012	29	2	2	4	25	9	70
2013	31	2	9	4	25	13	83
2014	34	2	2	5	3	30	75

5.2.6.5.5 Discards

Only Romania reported data on discards of piked dogfish. Thus, discards are not used in the assessment.

5.2.6.5.6 Fishing effort

The EWG 15-12 was not provided with quantitative information on fishing effort by all riparian countries. In the last four years, only Romania provided data regarding the number of gillnetters by vessel length class. The number of vessels fishing with gillnets for dogfish dropped from 265 in 2011 to 160 in 2012, and down to 25 in 2013.

Table 5.2.6.5.6.1. Piked dogfish in GSA 29. Number of gillnetters for piked dogfish in the Romanian area.

Vessel length (m)	Number of gillnets for dogfish in 2011	Number of gillnets for dogfish in 2012	Number of gillnets for dogfish in 2013	Number of gillnets for dogfish in 2014
< 6m	10	-	-	2
6-12 m	205	110	-	10
18-24 m	50	50	-	20
24-40 m	-	-	25	-
Total	265	160	25	32

Table 5.2.6.5.6.2. Piked dogfish in GSA 29. Romanian CPUE in commercial fishing, 2009-2014 period.

YEAR	Fishing gear	CPUE
2009		
LOA 6-12 m	gillnets	0.24 kg/gear/day
LOA 18-24 m	gillnets	0.40 kg/gear/day
LOA 24-40 m	gillnets	0.89 kg/gear/day
2010		
LOA 6-12 m	gillnets	0.18 kg/gear/day

2011		
LOA 6-12 m	gillnets	0.248kg/gear/day
LOA 18-24 m	gillnets	0.91 kg/gear/day
2012		
LOA 6-12 m	gillnets	8.8 kg/gear/day
LOA 12-18 m	gillnets	8.5 kg/gear/day
18-24	gillnets	6.0 kg/gear/day
2013		
LOA 6-12 m	long lines	20.65 kg/gear/day /
LOA 24-40 m	pelagic trawl	123.45 kg/gear/day
LOA 24-40 m	gillnets	8.91 kg/gear/day
2014		
LOA <6m	gillnets	7 kg/gear/day
LOA 6m-12m	gillnets	1.066 kg/gear/day
LOA 6m-12m	long lines	1.125 kg/gear/day
LOA 12-18m	gillnets	1.443 kg/gear/day
LOA 12-18m	trawl	5.608 kg/gear/day
LOA 24-40m	trawl	3.867 kg/gear/day

5.2.6.6 Scientific surveys

5.2.6.6.1 Survey #1

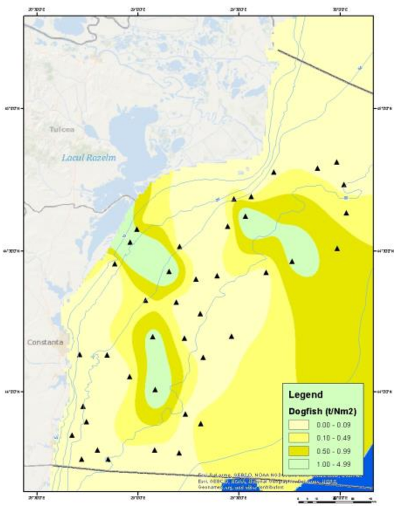
Only Romania reported data from surveys for piked dogfish.

5.2.6.6.1.1 Methods

In Romanian waters, the swept area method is applied to estimate density and biomass indices of piked dogfish.

5.2.6.6.1.2 Geographical distribution

In Romanian waters, the aggregations of piked dogfish are distributed on the entire shelf, especially at depth deeper than 20m. Two peaks of intense spawning and birth of juveniles are in spring and autumn off the Romanian coast.



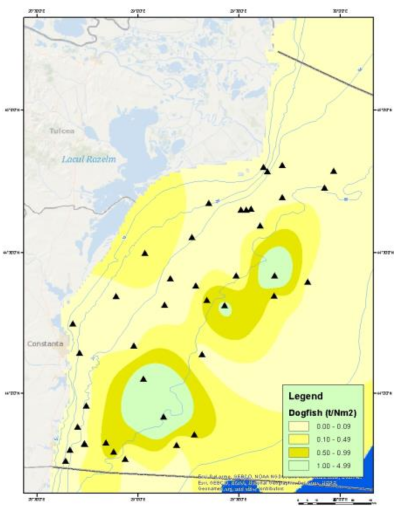


Fig. 5.2.6.6.1.2.1. Piked dogfish in GSA 29. Distribution of piked dogfish aggregations in May and October 2014 (Romanian trawl survey).

5.2.6.6.1.3 Trends in abundance and biomass

Results for estimated piked dogfish biomasses in May and November of 2009-2013 in Romanian waters are given in the following tables.

Table 5.2.6.6.1.3.1. Piked dogfish in GSA 29. Estimated piked dogfish biomass (t) in May and November of 2009-2014 in Romanian waters from the Romanian survey.

Species	2009	2010	2011	2012	2013	2014
Piked dogfish	967-2509	5635-13051	1173-1690	1436-1159	3181-4483	1520-1267

Table 5.2.6.6.1.3.2. Piked dogfish in GSA 29. CPUE for Romanian Black Sea areas estimated by the Romanian survey.

YEAR	2010		2011		2012		2013		2014	
Period	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Range (kg/hour)	3.6 – 98.63	4.5 – 106.22	5.8 – 24.9	5.0 - 24.83	1.1-19.2	1.5-134	5.5-115.8	0.95-200	4.25-50.3	5.45-39.21

Table 5.2.6.6.1.3.3. Piked dogfish in GSA 29. EstimateS of piked dogfish abundance and biomass in May–June, and October 2014 off Romanian coasts (Romanian trawl survey).

Depth range (m)	0 - 30m	30 – 50m	50-70 m	70-100m	Total
Investigated area (Nm2)	625	1150	825		2600
Variation of the catches (t/ Nm2)	0-2.86	0-1.64	0-1.1		0-2.86
Average catch (t/ Nm2)	0.65	0.343	0.149		0.304
Biomass of the fishing agglomerations (t)	406.62	394.23	123.27		790.22
Biomass extrapolated the Romanian shelf (t)					1519.67

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm2)	625	1150	875	2650
Variation of the catches (t/ Nm2)	0-0.33	0-1.56	0-2.23	0-2.23
Average catch (t/ Nm2)	0.048	0.143	0.532	0.2533
Biomass of the fishing agglomerations (t)	30.29	164.75	466.34	671.32
Biomass extrapolated the Romanian shelf (t)				1266.643

5.2.6.6.1.4 Trends in abundance by length or age

At EWG 15-12, only Romania presented data on size structure by length and age of piked dogfish.

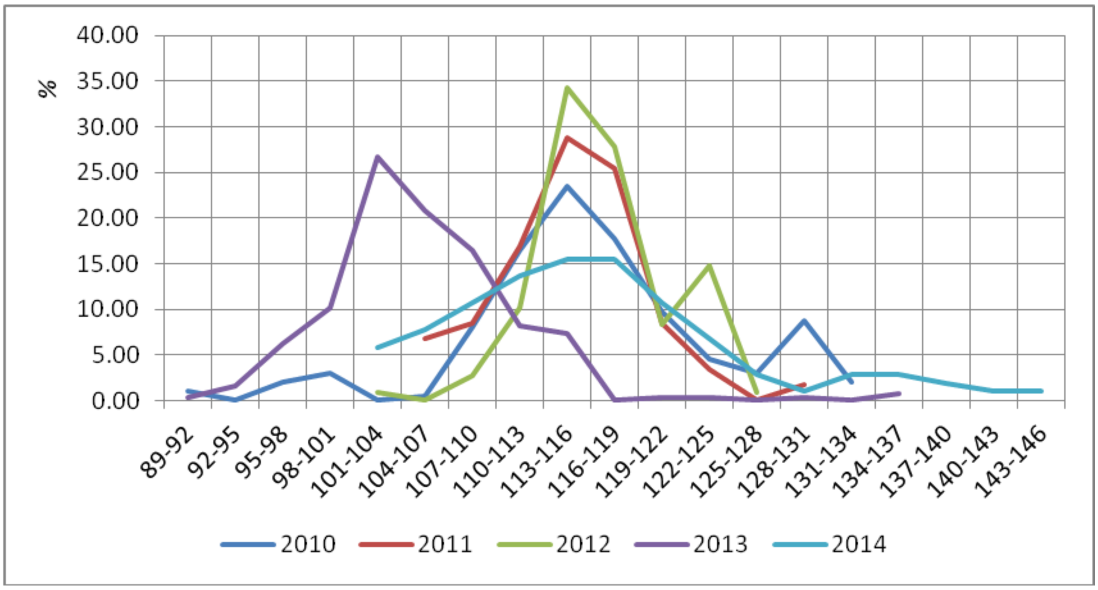


Fig. 5.2.6.6.1.4.1. Piked dogfish in GSA 29. Percentage of total number of individuals by length class caught in Romanian waters.

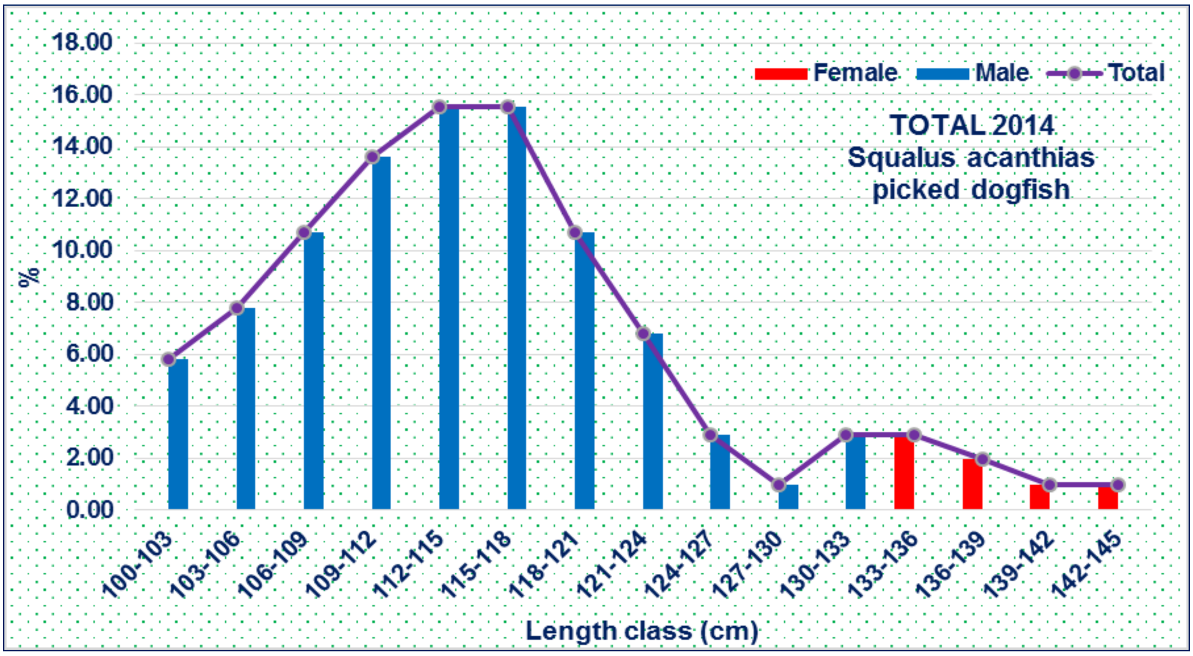


Fig. 5.2.6.6.1.4.2. Piked dogfish in GSA 29. Size structure by sex for piked dogfish in 2014 in Romanian waters.

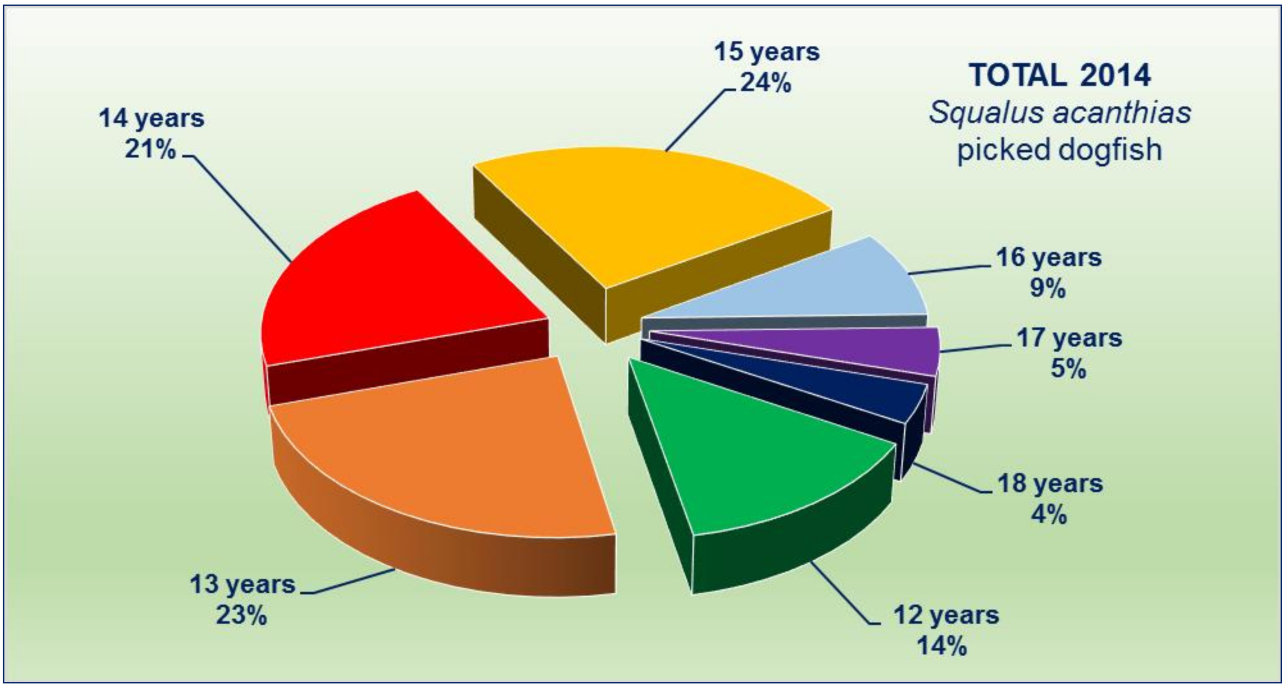


Fig. 5.2.6.6.1.4.3. Piked dogfish in GSA 29. Percentage by age class for piked dogfish 2014 in Romanian waters.

5.2.6.7 Stock Assessment

5.2.6.7.1 Methods

In 2014, EWG 14-14 applied two methods: VIT, as in previous years, and XSA for the first time. In EWG14-14, VIT program was used to estimate abundance and fishing mortality, while YPRLEN (NOAA Fisheries Toolbox Version 3.1) was used in the attempt to obtain reference points for dogfish in the Black Sea.

EWG15-12 used Extended Survivors Analysis (XSA – Darby and Flatman, 1994) to perform the assessment of piked dogfish stock in the Black Sea. XSA results were used as indicative of trends only. XSA has been applied using an age range from 7 to 19+ (period 1989-2014). FLR libraries were employed to carry out the XSA based assessment. The model was tuned with the CPUE at age derived from the Romanian scientific demersal surveys carried out in the period 2011-2014. Sensitivity analyses were conducted to assess the effect of the main parameters. Shrinkage values ranging from 0.5 to 2.5 (0.5 increasing) were used and tested. Comparison of trends between the settings has been done.

5.2.6.7.2 Input data

Total landings of piked dogfish from Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine in the period 1989-2014 were used for the assessment. Catch numbers-at-age were derived from catches length-frequency distribution by applying the growth parameters provided to the EWG. Table 5.2.6.7.2.1 lists the input parameters to the XSA, namely landings, catch numbers-at-age, weight-at-age, maturity at age, natural mortality at age and the tuning series at age.

Table 5.2.6.7.2.1. Piked dogfish in GSA 29. Input data to the XSA model.

Landings (t)

1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000

6159	2761	2924	2911	1618	2650	1837	1951	1585	1482	1629	2601
2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
895	602	452	421	251	302	211	206	235	75	104	70
2013	2014										
83	75										

Table 5.2.6.7.2.2. Piked dogfish in Black Sea. Catch numbers-at-age matrix (thousands)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
7	5.77	2.55	2.72	2.69	1.51	2.49	1.65	1.78	1.46
8	24.32	10.76	11.47	11.34	6.38	10.51	6.98	7.50	6.14
9	26.85	11.88	12.66	12.51	7.04	11.6	7.70	8.28	6.78
10	73.69	32.61	34.75	34.35	19.33	31.84	21.14	22.73	18.6
11	101.44	44.89	47.84	47.29	26.6	43.83	29.1	31.29	25.61
12	89.64	40.06	42.49	42.22	23.54	38.61	26.48	28.21	22.96
13	121.37	54.22	57.52	57.15	31.87	52.28	35.82	38.17	31.07
14	101.13	47.42	49.17	50.16	26.73	42.86	34.32	35.05	27.82
15	107.77	49.68	51.92	52.48	28.42	45.94	34.87	36.12	28.91
16	139.63	62.01	65.96	65.33	36.63	60.26	40.47	43.38	35.43
17	80.7	35.81	38.11	37.72	21.17	34.84	23.33	25.03	20.45
18	30.45	13.48	14.36	14.19	7.99	13.16	8.73	9.39	7.69
19+	7.75	3.43	3.65	3.61	2.03	3.35	2.22	2.39	1.96

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
7	1.37	1.51	2.36	0.72	0.67	0.01	0.71	1.03	0.01
8	5.78	6.38	9.94	3.05	4.02	0.01	2.12	3.11	2.41
9	6.38	7.04	10.97	3.36	10.36	0.01	2.2	1.03	2.48
10	17.5	19.31	30.13	9.23	17.13	0.24	0.46	0.01	4.89
11	24.09	26.59	41.47	12.7	21.48	0.54	0.01	0.01	19.56
12	21.5	23.66	37.56	12.58	22.44	4.66	0.01	0.01	14.67
13	29.1	32.02	50.81	16.97	19.79	11.05	0.12	1.03	12.19
14	25.47	27.62	47.63	22	12.44	12.18	0.79	4.14	2.48
15	26.68	29.08	48.74	20.46	4.27	12.96	3.16	9.3	0.01
16	33.28	36.68	57.58	18.23	1.32	5.61	5.57	8.28	2.41
17	19.22	21.19	33.21	10.44	0.27	6.99	8.72	3.14	2.41
18	7.23	7.98	12.45	3.81	0.01	4.96	11.76	1.03	0.01
19+	1.84	2.03	3.17	0.97	0.01	0.54	5.94	0.01	0.01

Age	2007	2008	2009	2010	2011	2012	2013	2014	
7	0.01	0.01	0.01	0.09	0.1	0.04	0.01	0.01	
8	0.01	0.01	0.01	0.39	0.42	0.16	0.01	0.01	
9	0.73	0.01	2.60	0.43	0.46	0.17	0.01	0.01	
10	1.46	0.01	13.83	1.18	1.26	0.48	0.01	0.01	
11	1.46	0.01	10.06	1.63	1.73	0.66	0.53	0.01	
12	2.92	0.96	5.89	1.43	1.52	0.62	1.07	1.63	

13	5.84	2.92	5.59	1.94	2.06	0.91	1.6	1.28	
14	5.11	1.94	5.25	1.56	1.65	2.77	2.14	3.50	
15	2.92	2.92	2.89	1.68	1.79	2.42	2.67	3.15	
16	5.11	5.82	2.01	2.24	2.38	1.62	1.07	0.82	
17	2.19	4.84	0.93	1.29	1.38	0.57	0.53	0.47	
18	1.46	1.94	0.01	0.49	0.52	0.20	0.53	0.70	
19+	0.01	0.96	0.01	0.12	0.13	0.05	0.53	0.47	

Table 5.2.6.7.2.3. Piked dogfish in Black Sea. Weight-at-age matrix (kg).

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
9	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
10	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
11	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
12	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
13	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
14	7.0	6.9	7.0	6.9	7.0	7.0	6.8	6.9	6.9
15	8.3	8.2	8.2	8.2	8.3	8.3	8.1	8.1	8.2
16	9.8	9.8	9.8	9.8	9.8	9.8	9.7	9.8	9.8
17	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
18	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
19+	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
7	1.5	1.5	1.5	1.5	1.7	1.6	1.5	1.5	1.4
8	1.9	1.9	1.9	1.9	2.2	2.1	1.9	1.9	1.9
9	2.4	2.4	2.4	2.4	2.8	2.6	2.4	2.4	2.4
10	3.0	3.0	3.0	3.0	3.5	2.8	3.0	3.0	3.0
11	3.7	3.7	3.7	3.7	4.3	3.5	3.6	3.7	3.7
12	4.6	4.6	4.6	4.7	5.3	4.3	4.4	4.6	4.6
13	5.7	5.7	5.7	5.7	6.6	5.4	5.7	5.7	5.7
14	6.9	7.0	6.9	6.5	8.2	6.6	7.1	7.1	7.1
15	8.2	8.2	8.1	7.6	9.6	7.8	8.3	8.3	8.3
16	9.8	9.8	9.8	9.6	11.3	9.2	9.8	9.8	9.8
17	11.0	11.0	11.0	10.9	12.7	10.4	11.0	11.0	11.0
18	12.3	12.3	12.3	12.3	12.0	11.6	12.3	12.3	12.3
19+	13.7	13.7	13.7	13.7	13.3	12.9	13.7	13.7	13.7

Age	2007	2008	2009	2010	2011	2012	2013	2014	
7	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	
8	1.8	1.7	1.7	1.7	1.9	1.9	1.9	1.9	
9	2.4	2.4	2.4	2.0	2.4	2.4	2.4	2.4	
10	3.0	3.0	3.0	2.5	3.0	3.0	3.0	3.0	

11	3.7	3.7	3.7	3.0	3.7	3.9	4.0	4.0	
12	4.6	4.6	4.6	3.6	4.6	4.6	4.6	4.2	
13	5.7	5.7	5.7	4.4	5.7	5.8	5.8	4.9	
14	7.1	7.1	7.1	5.4	7.1	7.7	7.0	5.6	
15	8.3	8.3	8.3	6.3	8.3	7.7	8.0	6.6	
16	9.8	9.8	9.8	7.4	9.8	9.9	10.0	7.9	
17	11.0	11.0	11.0	8.3	11.0	10.3	11.0	8.1	
18	12.3	12.3	10.8	9.2	12.3	12.4	12.5	9.3	
19+	13.7	13.7	12.0	10.2	13.7	13.8	13.8	11.0	

A fixed natural mortality (M) of 0.15 was used for each age class in the period 1989-2014. The following maturity vector was used in the whole investigated period.

Age	7	8	9	10	11	12	13	14	15	16	17	18	19+
Prop. Mat.	0.5	0.5	0.625	0.625	0.725	0.775	0.875	0.975	1.0	1.0	1.0	1.0	1.0

5.2.6.7.3 Results

The results indicated a steady and major reduction in the spawning stock biomass since 1989. The estimates of current rates of fishing mortality are high (around 0.25) and estimates of F for past years were erratic, exceeding 0.7 four times between 1999 and 2009. Detailed outputs can be traced in the following figures and tables.

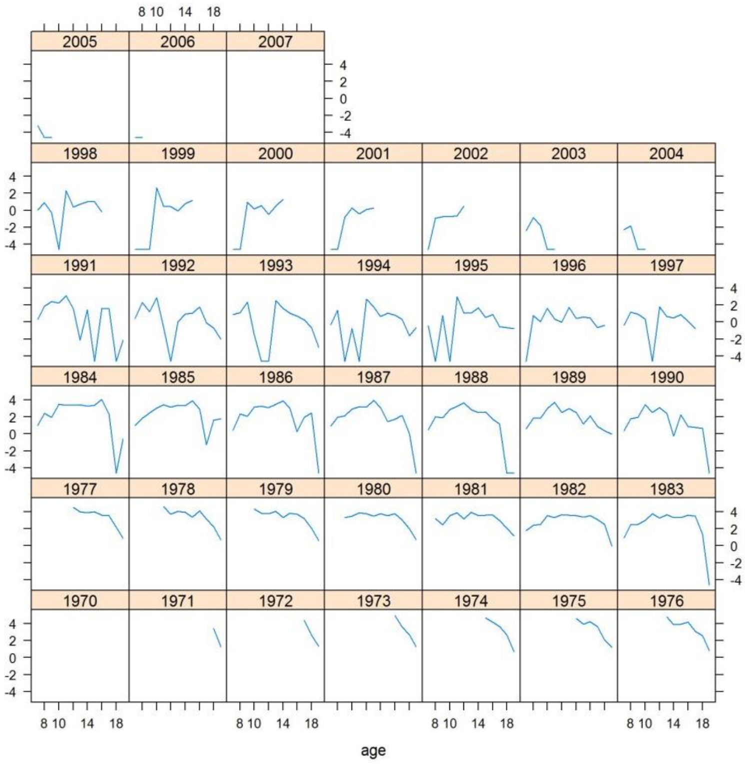


Figure 5.2.6.7.3.1. Piked dogfish in GSA 29. Cohorts.

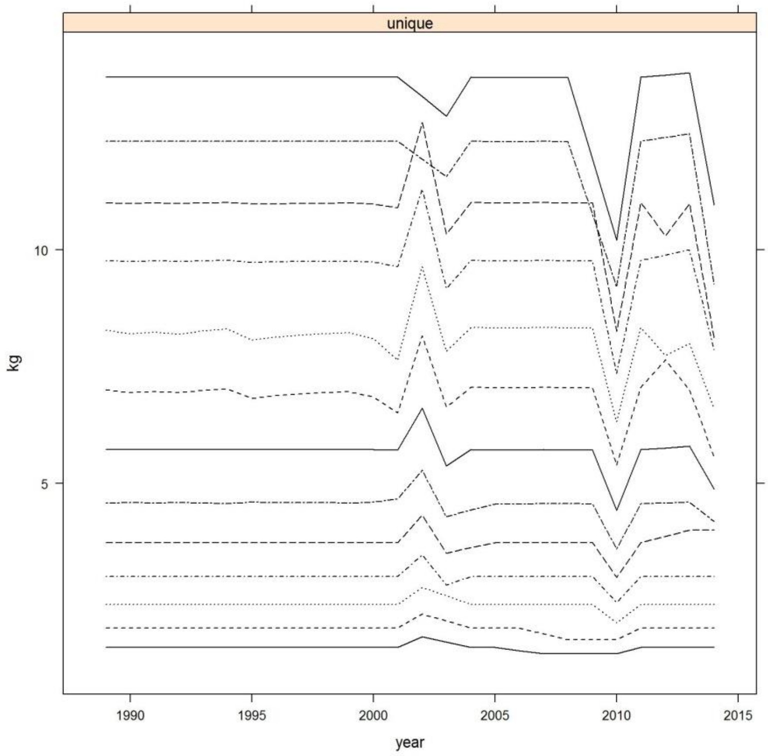


Figure 5.2.6.7.3.2. Piked dogfish in GSA 29. Weight-at-age.

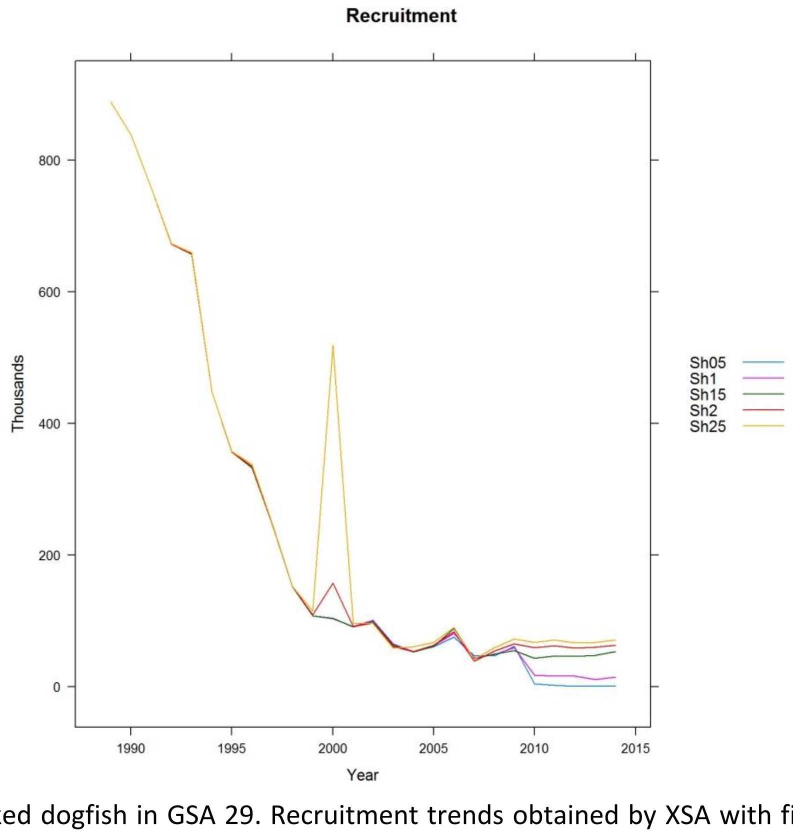


Figure 5.2.6.7.3.3. Piked dogfish in GSA 29. Recruitment trends obtained by XSA with five different shrinkage settings.

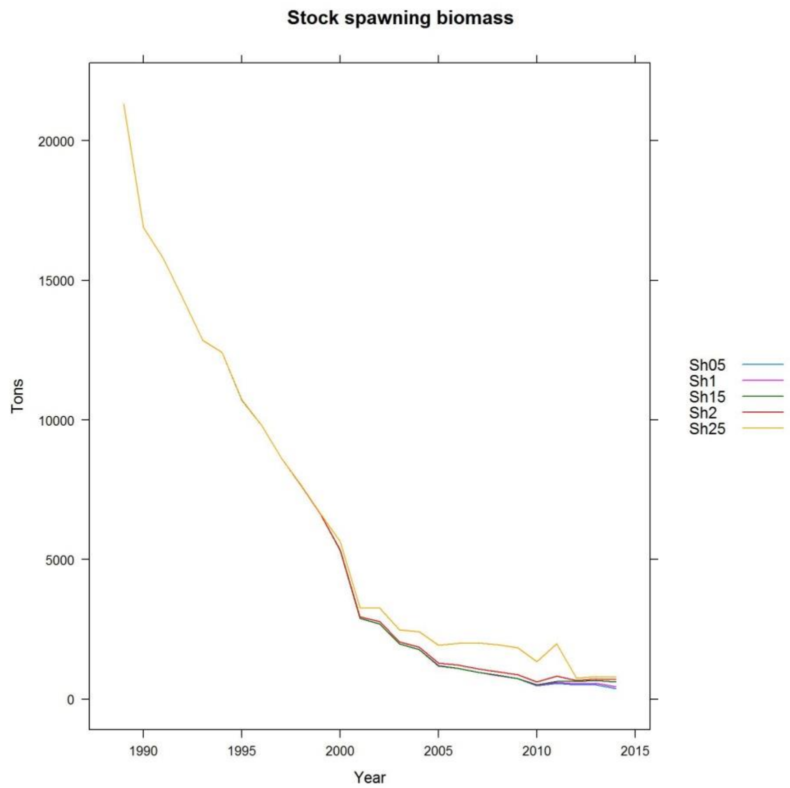


Figure 5.2.6.7.3.4. Piked dogfish in GSA 29. Spawning stock biomass (SSB) trends obtained by XSA with five different shrinkage settings.

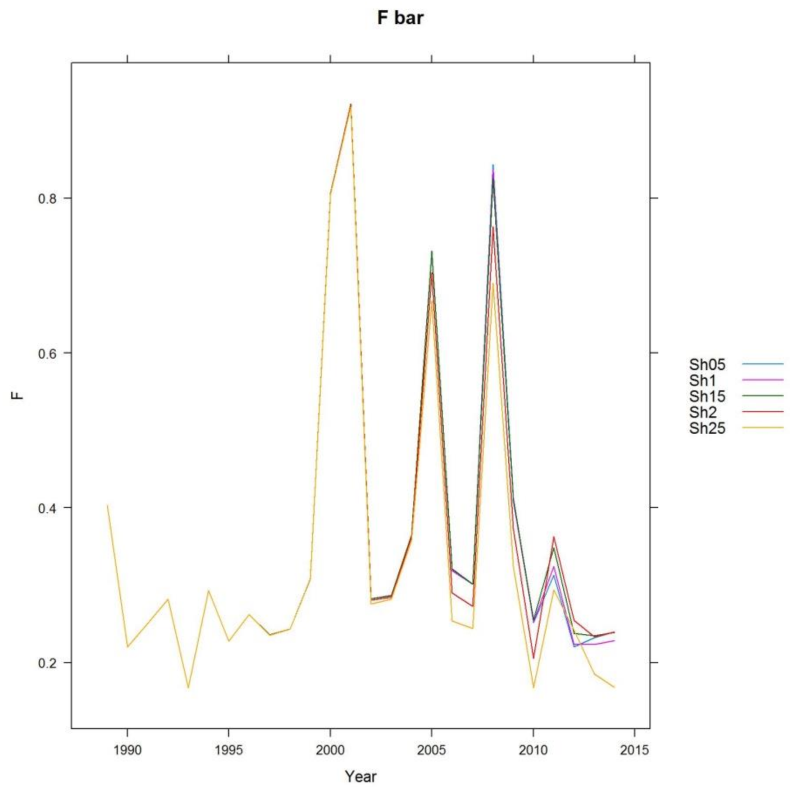


Figure 5.2.6.7.3.5. Piked dogfish in GSA 29. Fbar (10-17) trends obtained by XSA with five different shrinkage settings.

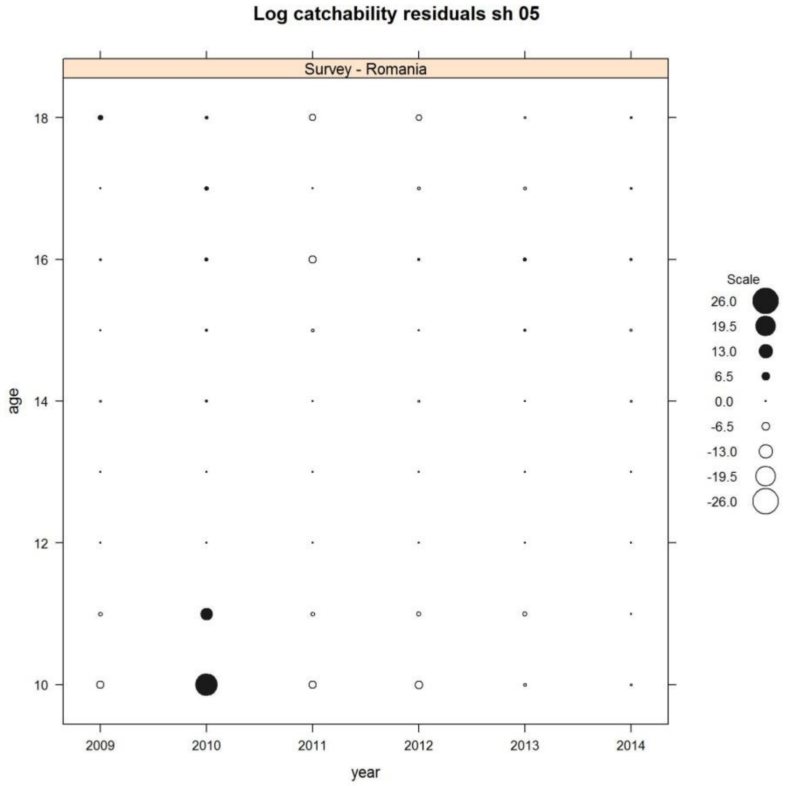


Figure 5.2.6.7.3.6. Piked dogfish in GSA 29. Log-catchability residuals for the tuning fleet (Romanian trawl survey) for the XSA with shrinkage 0.5.

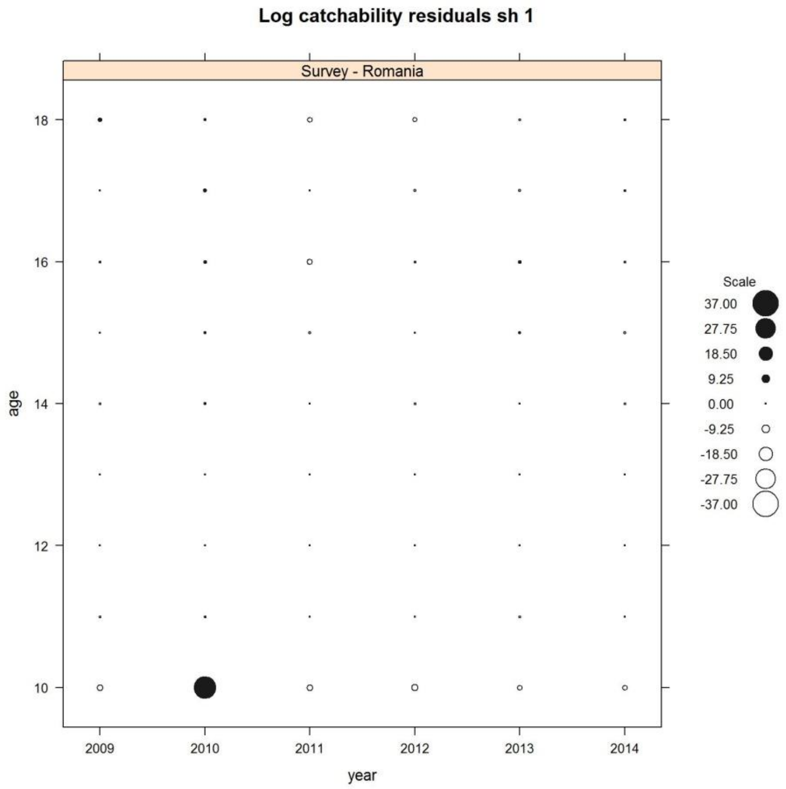


Figure 5.2.6.7.3.7. Piked dogfish in GSA 29. Log-catchability residuals for the tuning fleet (Romanian trawl survey) for the XSA with shrinkage 1.

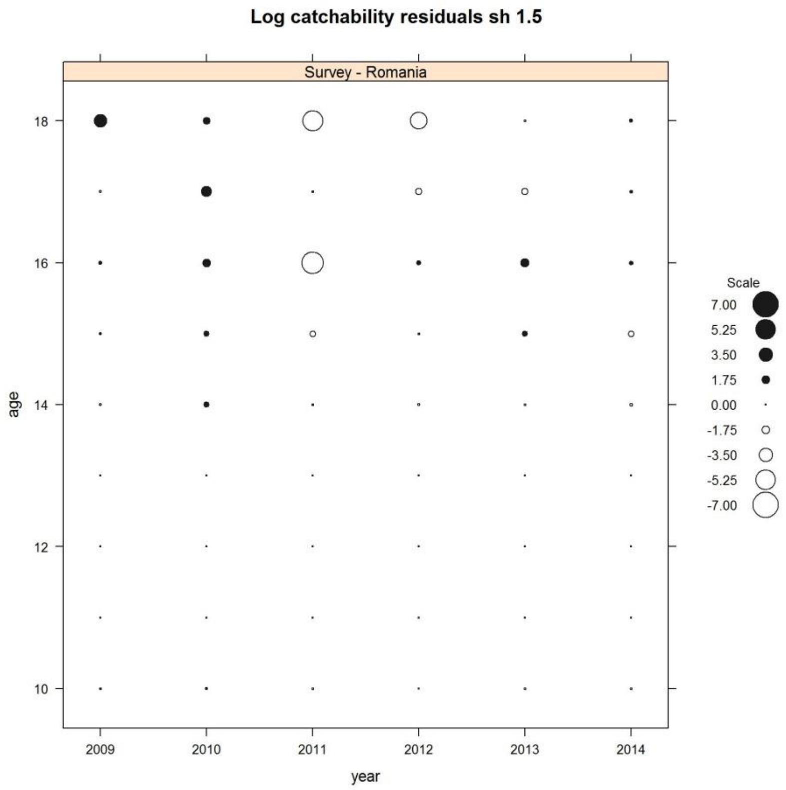


Figure 5.2.6.7.3.8. Piked dogfish in GSA 29. Log-catchability residuals for the tuning fleet (Romanian trawl survey) for the XSA with shrinkage 1.5.

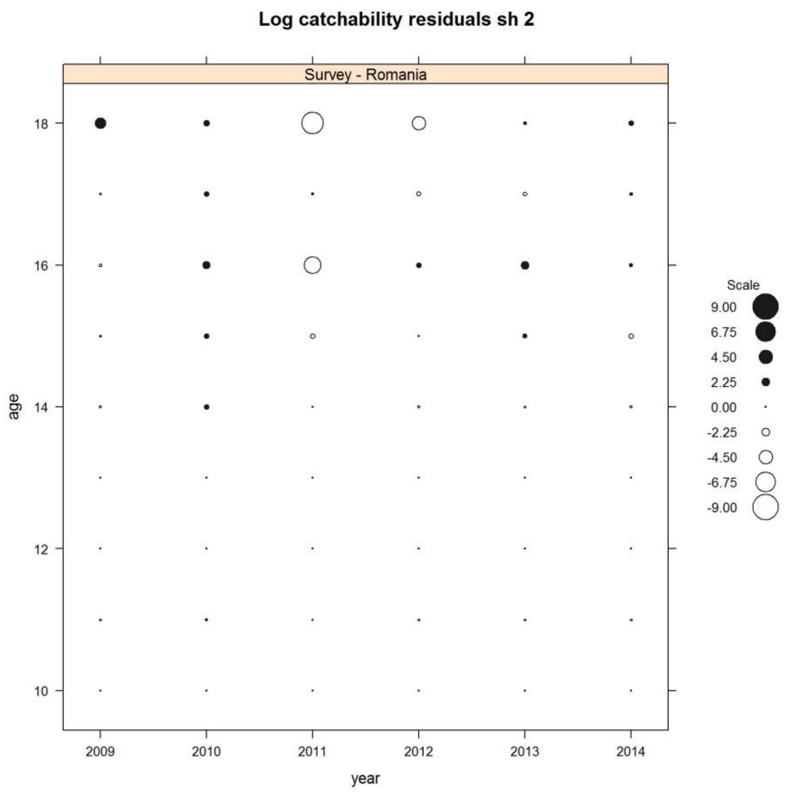


Figure 5.2.6.7.3.9. Piked dogfish in GSA 29. Log-catchability residuals for the tuning fleet (Romanian trawl survey) for the XSA with shrinkage 2.

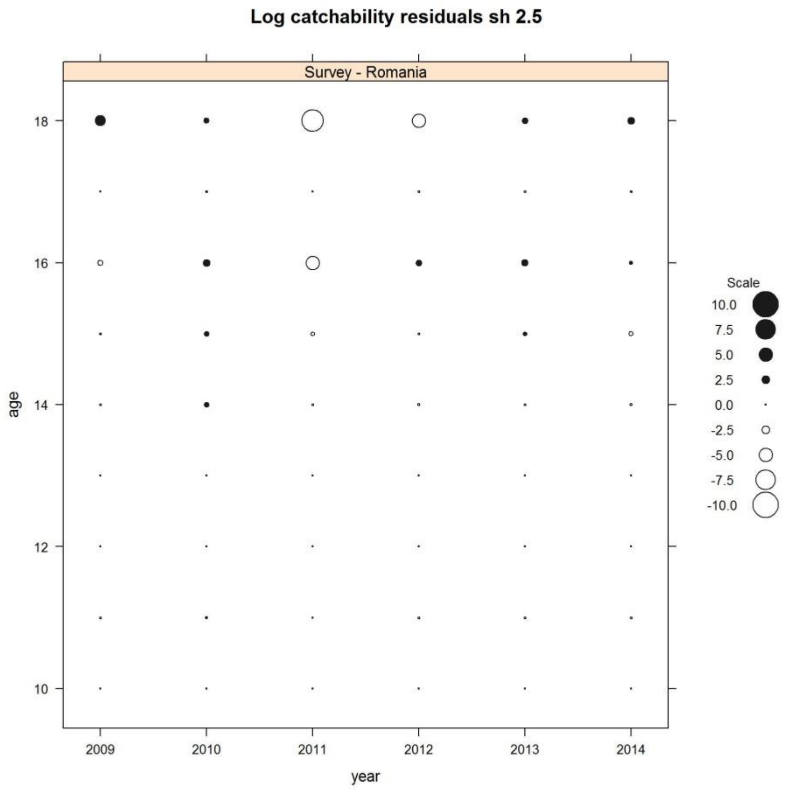


Figure 5.2.6.7.3.10. Piked dogfish in GSA 29. Log-catchability residuals for the tuning fleet (Romanian trawl survey) for the XSA with shrinkage 2.5.

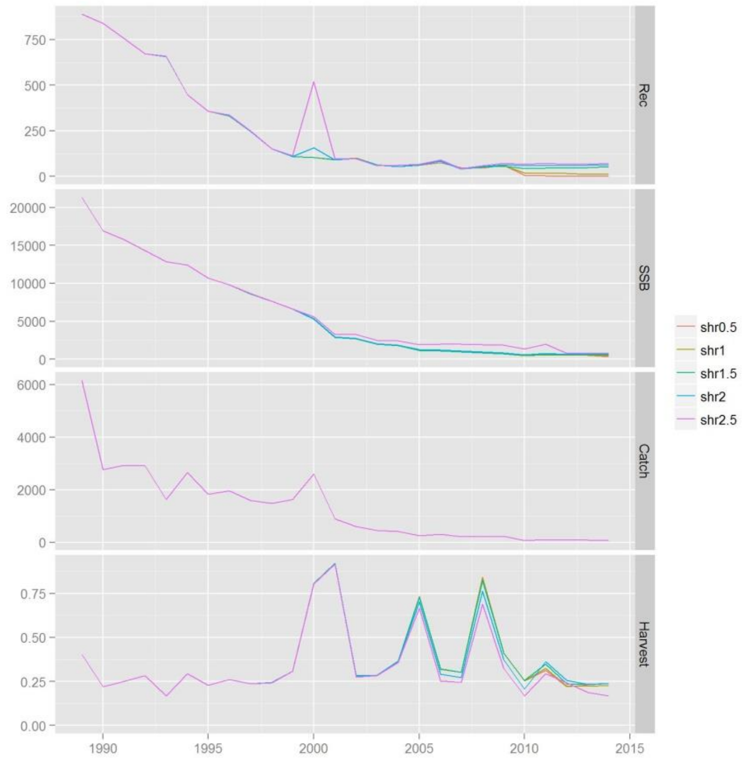


Figure 5.2.6.7.3.11. Piked dogfish in GSA 29. Sensitivity analysis on shrinkage weight (XSA with 5 different shrinkage settings).

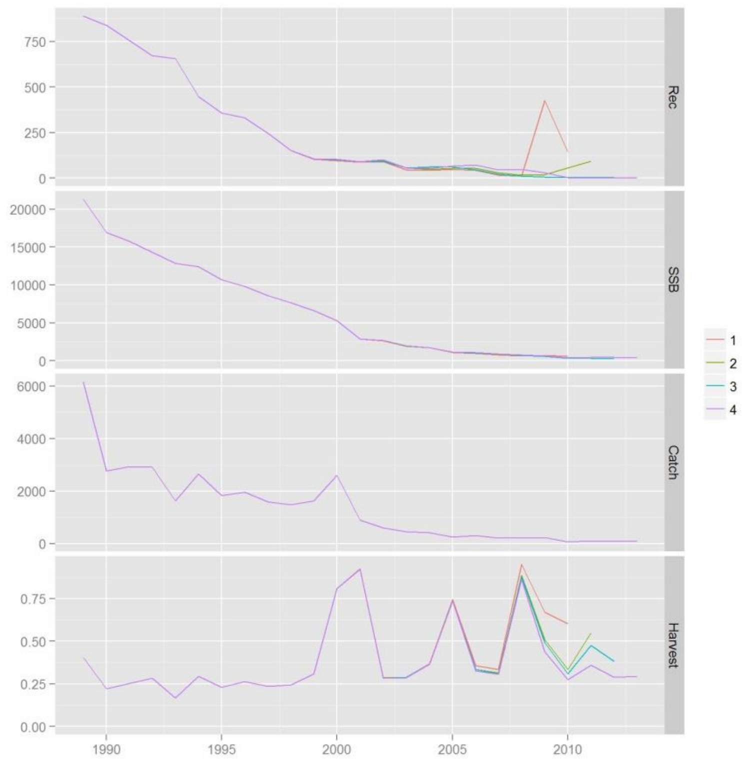


Figure 5.2.6.7.3.12. Piked dogfish in GSA 29. Retrospective analysis (years 2010-2013) from the XSA model with shrinkage 0.5.

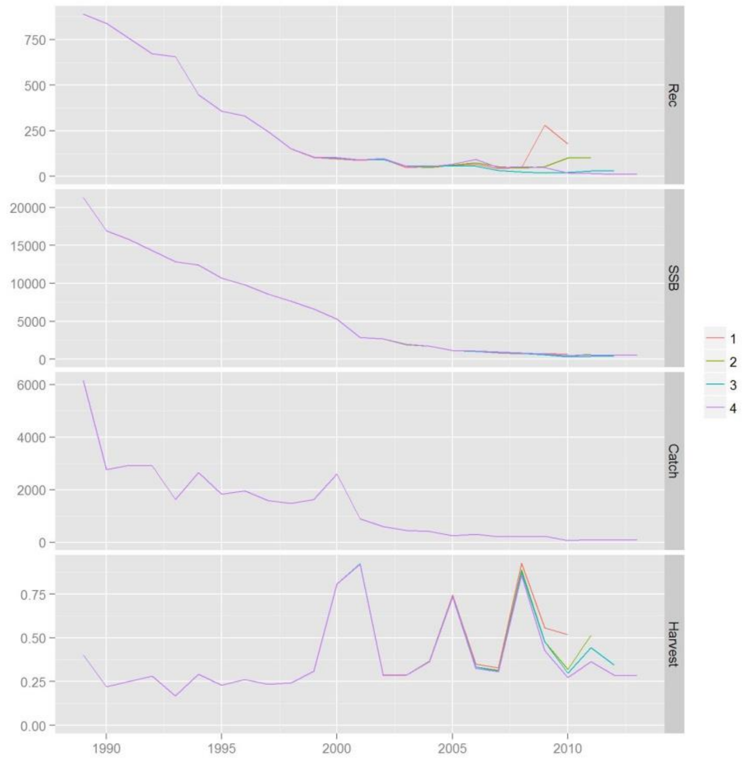


Figure 5.2.6.7.3.13. Piked dogfish in GSA 29. Retrospective analysis (years 2010-2013) from the XSA model with shrinkage 1.

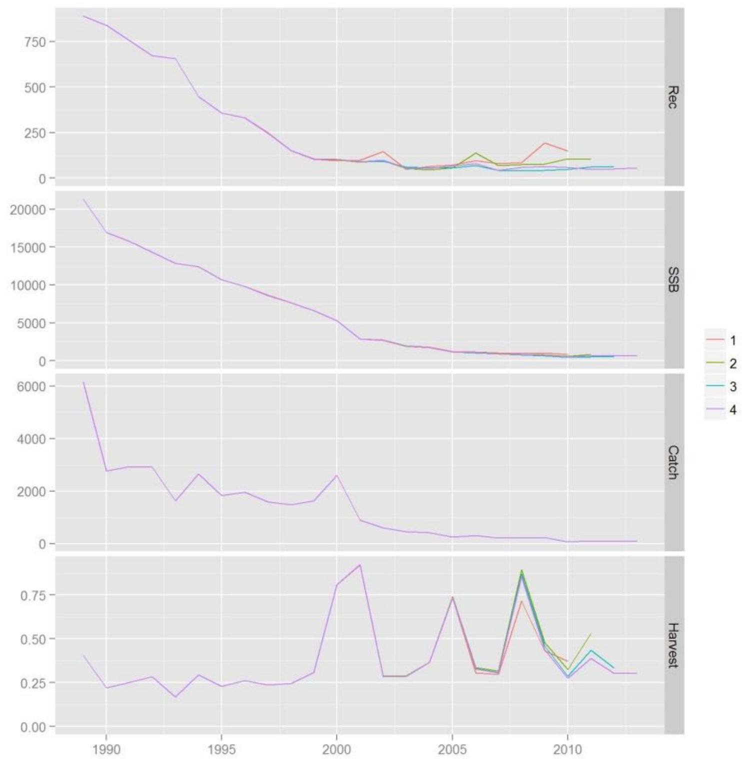


Figure 5.2.6.7.3.14. Piked dogfish in GSA 29. Retrospective analysis (years 2010-2013) from the XSA model with shrinkage 1.5.

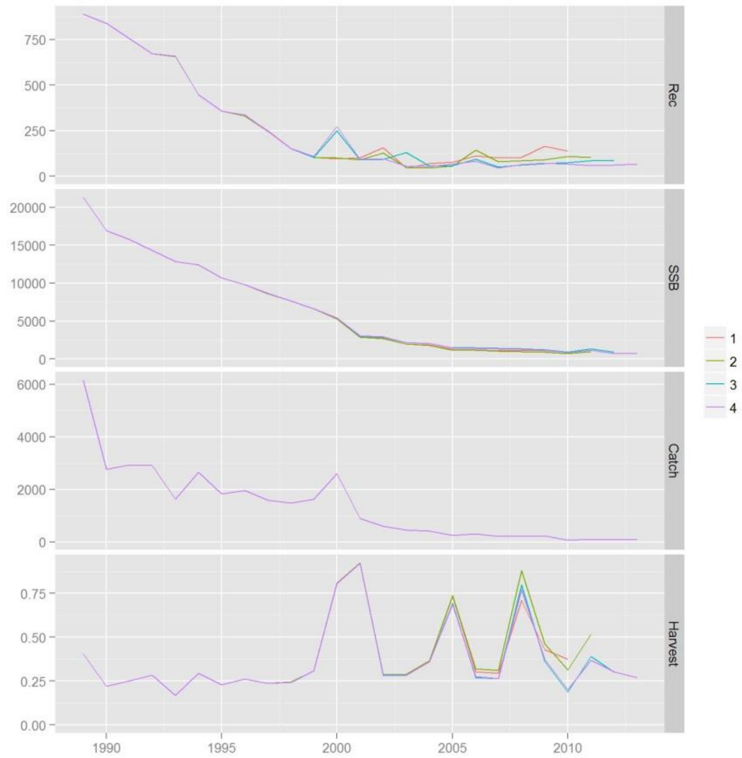


Figure 5.2.6.7.3.15. Piked dogfish in GSA 29. Retrospective analysis (years 2010-2013) from the XSA model with shrinkage 2.

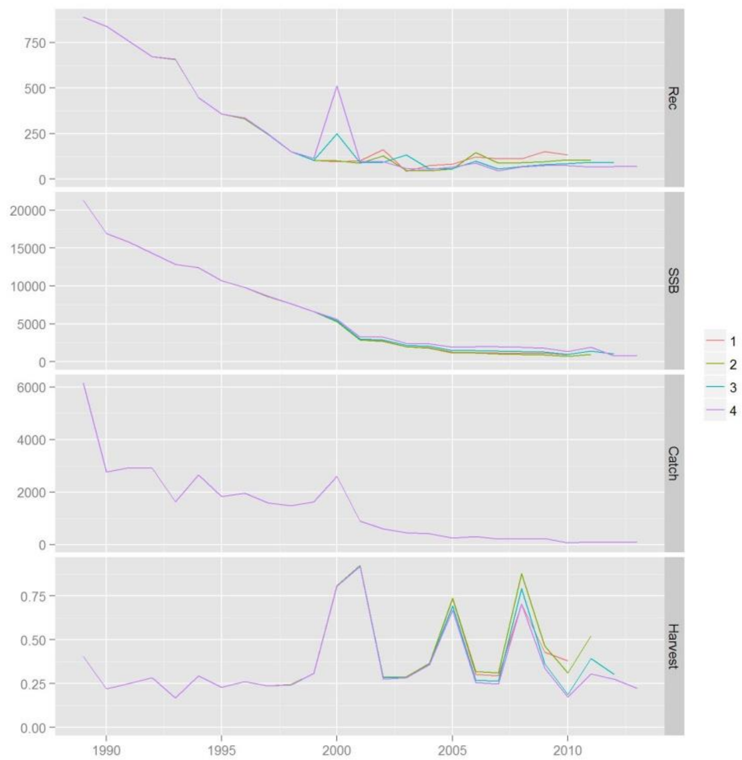


Figure 5.2.6.7.3.16. Piked dogfish in GSA 29. Retrospective analysis (years 2010-2013) from the XSA model with shrinkage 2.5.

Both log-catchability residuals and retrospective analysis indicate that the XSA model fitting with shrinkage 1.5 is providing the best results. Shrinkage 1.5 was not used in EWG14-14. However, it was decided to use this shrinkage at EWG15-12 because it was producing a more smoothed pattern in recruitment; therefore it was preferred to shrinkage 2 (and 2.5) that was producing an odd peak in recruitment around year 2000. The settings that minimized the residuals and showed the best diagnostic outputs were used for the final assessment, and are the following.

Fbar	Shrinkage	fse	rage	qage	shk.yrs	shk.age
10-17	1.5	0.5	13	17	3	5

The outputs of the XSA final assessment are shown in Figure 5.2.6.7.3.18.

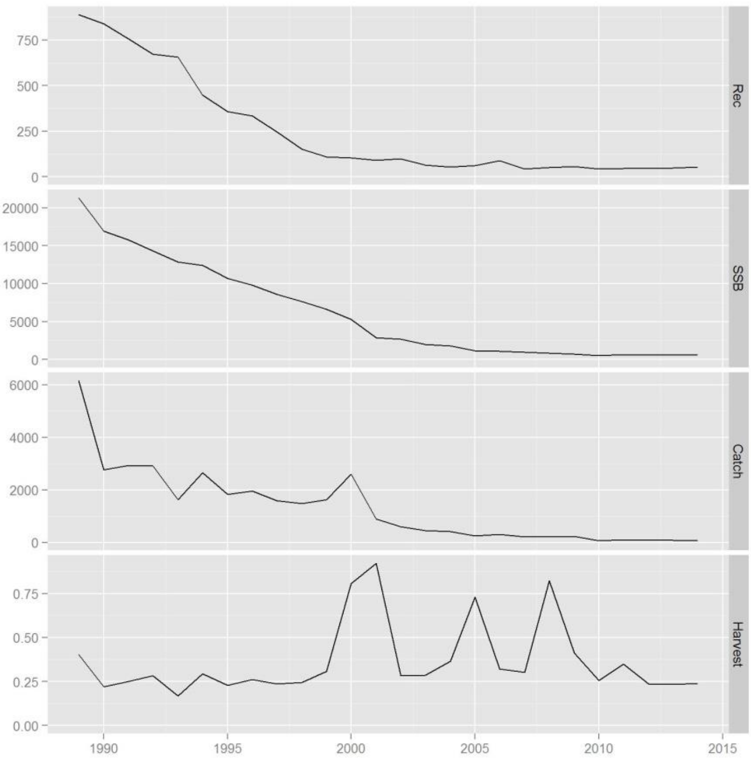


Figure 5.2.6.7.3.17. Piked dogfish in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

Table 5.2.6.7.3.1. Piked dogfish in GSA 29. Stock numbers at age (thousands) as estimated by XSA.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
7	888.44	838.18	757.78	671.91	656.79	447.76	356.80	332.22	246.59
8	862.69	759.33	719.06	649.70	575.82	563.91	383.08	305.57	284.30
9	778.00	719.96	643.58	608.26	548.68	489.70	475.61	323.25	256.05
10	734.96	644.72	608.65	542.19	511.93	465.72	410.72	402.22	270.54
11	677.74	564.22	524.66	491.63	434.80	422.69	371.31	333.90	325.10
12	561.16	489.23	443.98	407.20	379.28	349.56	323.15	292.60	258.36

13	507.55	399.83	383.92	342.72	311.31	304.61	265.05	253.57	225.67
14	406.46	324.25	293.84	277.08	241.96	238.38	213.68	194.90	182.84
15	323.06	256.02	235.09	207.29	191.95	183.46	165.41	152.07	135.23
16	266.47	178.08	174.27	154.18	129.73	138.84	115.28	110.02	97.38
17	151.03	99.81	95.75	88.80	72.09	77.68	63.60	61.68	54.45
18	77.32	55.12	52.68	47.05	41.43	42.41	34.53	33.09	29.87
19+	19.53	13.96	13.32	11.90	10.49	10.73	8.74	8.38	7.57

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
7	151.78	107.59	103.83	90.88	98.46	63.00	52.73	61.42	88.05
8	210.88	129.37	91.20	87.18	77.55	84.12	54.21	44.73	51.91
9	239.00	176.15	105.43	69.28	72.21	63.02	72.39	44.70	35.61
10	214.09	199.79	145.08	80.56	56.51	52.54	54.23	60.27	37.51
11	215.60	168.03	154.05	96.92	60.78	32.75	45.00	46.25	51.87
12	256.06	163.22	119.96	94.12	71.64	32.39	27.68	38.72	39.80
13	201.07	200.45	118.53	68.40	69.33	40.84	23.55	23.82	33.32
14	165.41	146.07	142.82	54.88	43.13	41.32	24.90	20.16	19.55
15	131.56	118.74	100.10	78.74	26.83	25.58	24.26	20.70	13.51
16	89.57	88.48	75.22	40.94	48.79	19.13	10.00	17.95	9.19
17	50.95	46.22	42.13	11.32	18.32	40.77	11.26	3.44	7.77
18	27.89	26.02	20.12	5.45	0.06	15.52	28.60	1.60	0.04
19+	7.06	6.58	5.05	1.36	0.06	1.68	14.33	0.02	0.04

Age	2007	2008	2009	2010	2011	2012	2013	2014	
7	42.55	49.24	54.90	43.07	46.28	45.99	47.44	52.91	42.55
8	75.78	36.61	42.37	47.24	36.99	39.74	39.54	40.82	75.78
9	42.44	65.21	31.50	36.46	40.30	31.45	34.06	34.03	42.44
10	28.35	35.85	56.12	24.70	30.98	34.26	26.91	29.30	28.35
11	27.75	23.05	30.85	35.47	20.17	25.50	29.04	23.15	27.75
12	26.49	22.53	19.83	17.22	29.02	15.75	21.33	24.51	26.49
13	20.65	20.09	18.50	11.60	13.49	23.57	12.98	17.37	20.65
14	17.37	12.35	14.59	10.74	8.19	9.70	19.44	9.69	17.37
15	14.52	10.21	8.83	7.68	7.80	5.51	5.78	14.75	14.52
16	11.62	9.79	6.08	4.92	5.06	5.05	2.50	2.50	11.62
17	5.67	5.26	3.03	3.37	2.16	2.14	2.84	1.16	5.67
18	4.45	2.85	0.04	1.74	1.70	0.58	1.32	1.96	4.45
19+	0.03	1.39	0.04	0.42	0.42	0.14	1.31	1.29	0.03

Table 5.2.6.7.3.2. Piked dogfish in GSA 29. XSA summary results.

	Fbar10-17	Recruitment (thousands)	SSB (t)	Catch (t)	Landings (t)
1989	0.40	888	21327	6159	6159
1990	0.22	838	16901	2761	2761

1991	0.25	758	15790	2924	2924
1992	0.28	672	14336	2911	2911
1993	0.17	657	12851	1618	1618
1994	0.29	448	12423	2650	2650
1995	0.23	357	10717	1837	1837
1996	0.26	332	9805	1951	1951
1997	0.24	247	8630	1585	1585
1998	0.24	152	7648	1482	1482
1999	0.31	108	6630	1629	1629
2000	0.81	104	5310	2601	2601
2001	0.92	91	2903	895	895
2002	0.28	99	2690	602	602
2003	0.29	63	1980	452	452
2004	0.36	53	1777	421	421
2005	0.73	61	1193	251	251
2006	0.32	88	1106	302	302
2007	0.30	43	957	211	211
2008	0.83	49	849	206	206
2009	0.41	55	738	235	235
2010	0.26	43	511	75	75
2011	0.35	46	634	104	104
2012	0.24	46	625	70	70
2013	0.23	47	670	83	83
2014	0.24	53	616	75	75

Table 5.2.6.7.3.3. Piked dogfish in GSA 29. F at age.

	F at age						
	7	8	9	10	11	12	13
1989	0.01	0.03	0.04	0.11	0.18	0.19	0.30
1990	0.00	0.02	0.02	0.06	0.09	0.09	0.16
1991	0.00	0.02	0.02	0.06	0.10	0.11	0.18
1992	0.00	0.02	0.02	0.07	0.11	0.12	0.20
1993	0.00	0.01	0.01	0.04	0.07	0.07	0.12
1994	0.01	0.02	0.03	0.08	0.12	0.13	0.20
1995	0.00	0.02	0.02	0.06	0.09	0.09	0.16
1996	0.01	0.03	0.03	0.06	0.11	0.11	0.18
1997	0.01	0.02	0.03	0.08	0.09	0.10	0.16
1998	0.01	0.03	0.03	0.09	0.13	0.09	0.17
1999	0.02	0.05	0.04	0.11	0.19	0.17	0.19
2000	0.02	0.12	0.12	0.25	0.34	0.41	0.62
2001	0.01	0.04	0.05	0.13	0.15	0.16	0.31
2002	0.01	0.06	0.17	0.40	0.48	0.41	0.37
2003	0.00	0.00	0.00	0.00	0.02	0.17	0.34
2004	0.01	0.04	0.03	0.01	0.00	0.00	0.01

2005	0.02	0.08	0.03	0.00	0.00	0.00	0.05
2006	0.00	0.05	0.08	0.15	0.52	0.51	0.50
2007	0.00	0.00	0.02	0.06	0.06	0.13	0.36
2008	0.00	0.00	0.00	0.00	0.00	0.05	0.17
2009	0.00	0.00	0.09	0.31	0.43	0.39	0.39
2010	0.00	0.01	0.01	0.05	0.05	0.09	0.20
2011	0.00	0.01	0.01	0.04	0.10	0.06	0.18
2012	0.00	0.00	0.01	0.02	0.03	0.04	0.04
2013	0.00	0.00	0.00	0.00	0.02	0.06	0.14
2014	0.00	0.00	0.00	0.00	0.00	0.07	0.08

	F at age						
	14	15	16	17	18	19+	
1989	0.31	0.45	0.83	0.86	0.55	0.55	
1990	0.17	0.23	0.47	0.49	0.31	0.31	
1991	0.20	0.27	0.52	0.56	0.35	0.35	
1992	0.22	0.32	0.61	0.61	0.39	0.39	
1993	0.13	0.17	0.36	0.38	0.23	0.23	
1994	0.22	0.31	0.63	0.66	0.41	0.41	
1995	0.19	0.26	0.48	0.50	0.32	0.32	
1996	0.22	0.30	0.55	0.58	0.37	0.37	
1997	0.18	0.26	0.50	0.52	0.33	0.33	
1998	0.18	0.25	0.51	0.52	0.33	0.33	
1999	0.23	0.31	0.59	0.68	0.40	0.40	
2000	0.45	0.74	1.74	1.90	1.10	1.10	
2001	0.57	0.33	0.65	5.08	1.40	1.40	
2002	0.37	0.19	0.03	0.02	0.20	0.20	
2003	0.38	0.79	0.38	0.20	0.42	0.42	
2004	0.03	0.15	0.92	1.80	0.59	0.59	
2005	0.25	0.66	0.69	4.20	1.18	1.18	
2006	0.15	0.00	0.33	0.41	0.28	0.28	
2007	0.38	0.24	0.64	0.54	0.44	0.44	
2008	0.19	0.37	1.02	4.81	1.32	1.32	
2009	0.49	0.43	0.44	0.40	0.34	0.34	
2010	0.17	0.27	0.67	0.53	0.36	0.36	
2011	0.24	0.28	0.71	1.17	0.40	0.40	
2012	0.37	0.64	0.42	0.34	0.47	0.47	
2013	0.13	0.69	0.62	0.22	0.57	0.57	
2014	0.49	0.26	0.43	0.57	0.49	0.49	

5.2.6.8 Reference points

5.2.6.8.1 Methods

Last year during EWG14-14, YPR-LEN analyses estimated $F_{0.1}$ = 0.204 proxy for F_{MSY}. Given (a) the uncertainty in the VIT and YPR-LEN analyses, linked to the assumption of constant recruitment, (b) the preliminary nature of the XSA analysis, and (c) the absence of more reliable information, EWG considered precautionary to use the F_{MSY} value ($F_{0.1}$ = 0.03 as proxy for F_{MSY}) estimated by ICES (ICES, 2014) for piked dogfish in the North East Atlantic as an appropriate proxy for F_{MSY} for piked dogfish in the Black Sea. EWG15-12 agreed in using the package FLBRP, available in FLR, to estimate the reference points for piked dogfish in the Black Sea.

5.2.6.8.2 Input data

Input data were the same as those used to run the assessment with XSA.

5.2.6.8.3 Results

$F_{0.1}$ = 0.08 proxy for F_{MSY} was estimated by means of FLBRP. The current F estimated by XSA is 0.24; estimates of F for past years were erratic, exceeding 0.7 four times during 1999 to 2009. Although, the results can be viewed as being uncertain, they are indicative of the status of piked dogfish. The stock is estimated to be severely depleted and fished above F_{MSY}.

5.2.6.9 Data quality

The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. As in previous years, EWG15-12 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-age data. Improvement of catch statistics regarding *Squalus acanthias* in the Black Sea area is crucial. Catch information is vital for the successful management of this species. Also, the joint surveys (6 Black Sea countries) are necessary to follow the distribution patterns, spawning areas, CPUE series, biomass estimations, diet, maturity indices etc. Nevertheless, XSA results indicated a steady and major reduction in the spawning stock biomass since 1989 and linked to the poor recruitment during the past couple of years there seems to be no indication of a stock recovery. Discards are not used in the assessment. However, official data report 260 tons of piked dogfish discarded in 2011 by the Romanian fleet against few tons usually discarded each year. The 2011 information must be checked and verified.

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of catch at age from several countries and an internationally coordinated bottom trawl survey.

5.2.6.10 Short term predictions 2015-2017

5.2.6.10.1 Method

No short term forecast was performed as the assessment is only indicative of trends.

5.2.6.11 Medium term predictions

5.2.6.11.1 Method

Not conducted.

5.2.6.12 Stock advice

STECF EWG 15-12 concludes that on the basis of precautionary considerations, there should be no directed fisheries for piked dogfish in GSA 29 and all bycatches mortality should be minimized in 2016. This corresponds to a 0 TAC in 2016 for this species.

5.2.7 STOCK ASSESSMENT OF WHITING

5.2.7.1 Stock Identification

In the Black Sea, whiting is one of the most abundant species among the demersal fishes. It does not undertake distant migrations, spawning occurs mainly in the cold season within the whole habitat area (Fig. 5.2.7.1). The whiting produces pelagic juveniles, which inhabit the upper 10-meter water layer for about a year. The adult whiting is cold-living, preferring temperatures 6-10 C. Fishes below age 6 dominate the whiting population, the older year classes are found in catches rarely. It is found all along the shelf where dense commercial concentrations are formed by 1-3 year old fishes in the water down to 150 m depth, most often between 60-120 m (Shlyakhov, 1983; Ozdamar et al, 1996). Such concentrations on the shelf of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine do not occur every year; they appear at periods of 4-6 years in the years of appearance of highly productive year classes. In these countries, whiting is rarely the target species in fisheries and is usually yielded as by-catch during trawl fishing for other fish species or during non-selective fishing with fixed nets in the coastal areas (Shlyakhov and Daskalov, 2008). In the vicinity of the southern coast of the Black Sea whiting concentrations are more stable.

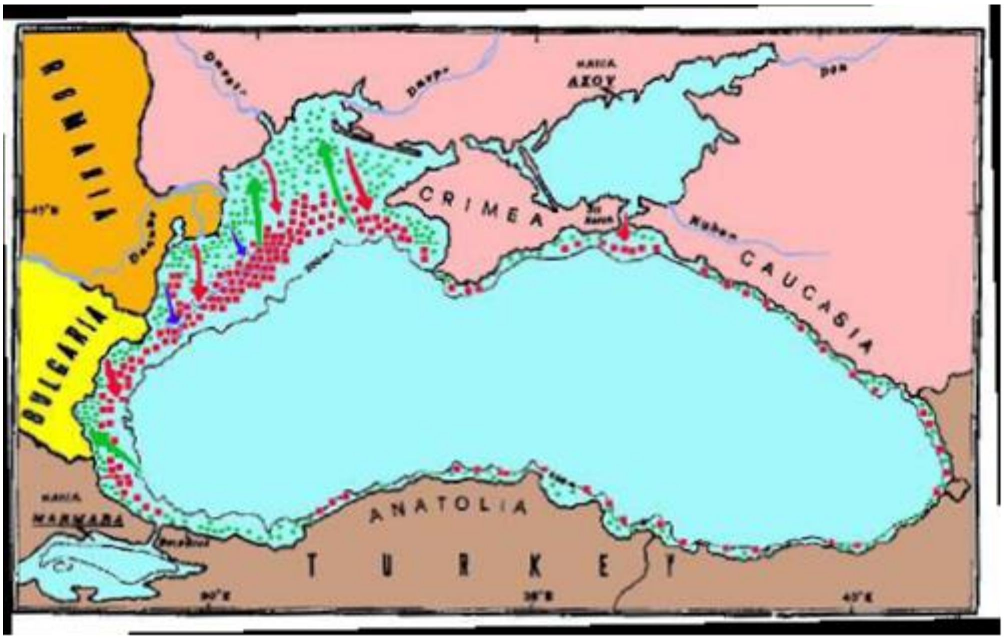


Fig. 5.2.7.1. Distribution of Whiting in the Black Sea.

The problem of units for whiting stocks in the Black Sea has not been settled yet. Fisheries experts from the Black Sea specify the stock as shared although this fish does not undertake long migrations; its whole stock (or two different stocks – Eastern and Western) is exploited by each Black Sea country in their waters. The part of the stock (or local stocks) that is distributed outside the Turkish waters is lightly exploited, mainly as a bycatch of other fisheries.

5.2.7.2 Growth

The analysis performed by Maximov et al. (2011) shows that the highest value for L asymptotic of the whiting was calculated in Ukrainian waters (39 cm) with the lowest growth rate (k = 0.106), accordingly. In Bulgarian and Romanian marine area the values are very similar and lower, as regards the asymptotic length (Table 5.2.7.2.1).

Table 5.2.7.2.1. Whiting in GSA 29. Growth estimated in the North-Western part of the Black Sea (*Maximov et al.*, 2011).

Country	L∞	K	t_0	1	2	3	4	5	6
Bulgaria	29.83	0.157	-2.49	12.6	15.1	17.2	19.1	20.6	22.0
Romania	26.30	0.160	-2.19	10.5	12.8	14.8	16.6	18.0	19.2
Ukraine	39.00	0.106	-1.324	8.5	11.6	14.3	16.8	19.0	21.0

Sampling by month the commercial landings of the bottom trawls operating in 2013 and 2014 along Turkish waters (Samsun Shelf Area and west Black Sea Turkish coasts) and Romania waters allows collecting information on length. They are synthetized in table 5.2.7.2.2 (Radu and Maximov, 2013, 2014).

Table 5.2.7.2.2. Whiting in GSA 29. Length composition by country (Radu and Maximov, 2013,2014).

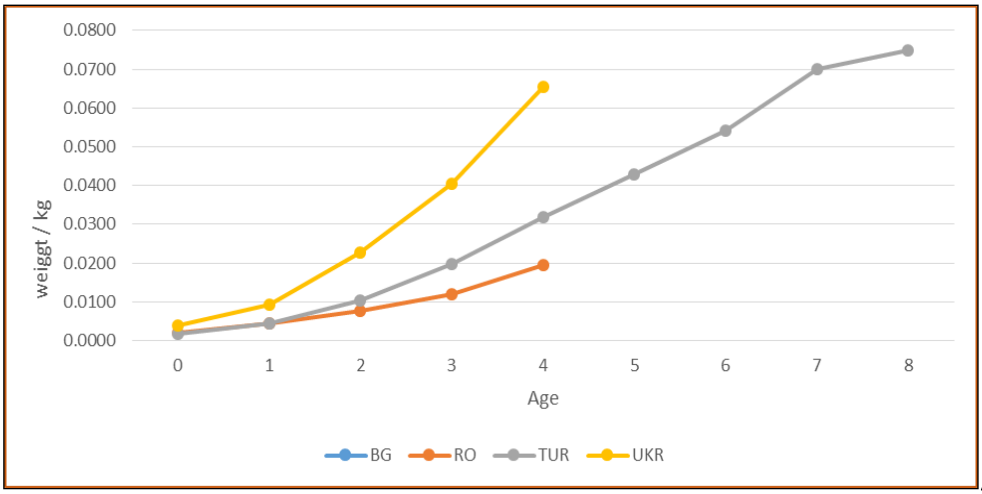
Year Country	2013 Romania	2013 Turkey	2014 Romania	2014 Turkey	2014 Bulgaria
length range (cm)	5.0-16.5	5.4 - 22.7	5.5 - 19.0	5.2 - 24.3	7-19.5
weight range (g)	1.15-46.12	1.17 - 82.99	1.125 - 42.397	1.11 - 138.21	
average length (cm)	10.38	12.37 (±0.07)	11.341	11.84 (±0.07)	
average weight (g)	8.58	16.07 (±0.27)	10.562	14.81 (±0.33)	
age groups range (y)	0-4	0-8	0-4	0-6	1-4
most relevant age group	age 2 (48.42%) age 3 (26,53%) age 1 (20,59%)	age 2 (48.42%) age 3 (26.53%) age 1 (20.59%)	age 2 (38.27 %) age 1 (38,10%) age 3 (13,44%)	age 1 (78.39%) age 2 (12.36%) age 3 (4.19%)	

The analysis on the commercial data gathered in 2013 and 2014 (Radu and Maximov, 2013, 2014) allows to calculate the growth parameter of whiting for Romania, Bulgaria and Turkey (Table 5.2.7.2.2) and lets to show catches in terms of age components (Fig. 5.2.7.2.1).

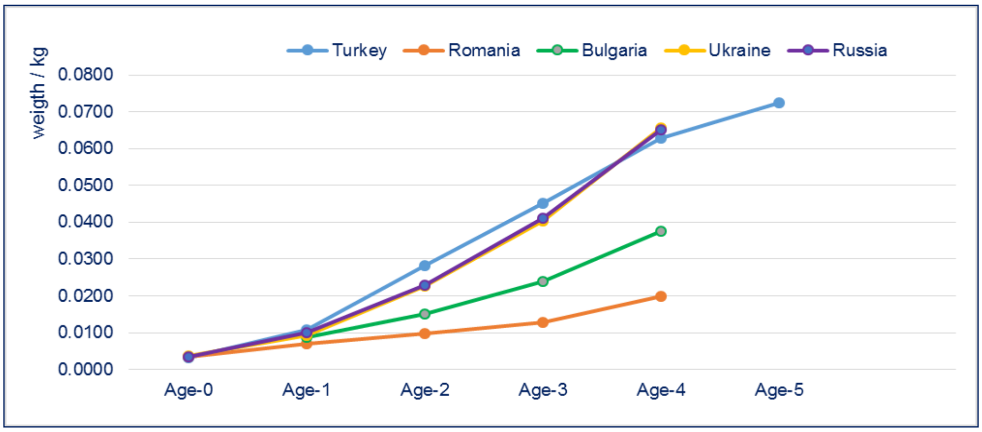
Table 5.2.7.2.3. Whiting in GSA 29. VBGF parameters calculated for 2013 and 2014 (Radu and Maximov, 2014).

Year	Country	L∞	K	t_0	a	b
2014	Bulgaria	12.05	0.41	-0.01	0.0009	2.7700
2014	Romania	20.00	0.238	-1.084	0.0094	3.1018
2014	Turkey	31.60	0.186	-1.428	0.0059	3.0941
2013	Romania	18.201	0.289	-1.0848		
2013	Turkey	24.307	0.323	-1.468		

Otoliths age reading of whiting carried out shows large discrepancies, judging by the differences in average weight-at-age in determining the age of fish older than two years (Figure 5.2.7.2.1). This could be an indication of the existence of various local whiting stocks or non intercalibrated age readings.



A



B

Figure 5.2.7.2.1. Whiting in GSA 29. Average weight at age by country (A=2013,B=2014)

From the data available the length-weight relationship's parameters of whiting in the Black Sea are shown in table 5.2.7.2.3.

Table 5.2.7.2.4. Whiting in GSA 29. Length weight relationship by country in 2013 and 2014 (Radu and Maximov, 2013, 2014).

Year	Country	a	b
2013	Romania	0.0127	2.773
2013	Turkey	0.007	3.02
2014	Bulgaria	0.0009	2.7700
2014	Romania	0.0094	3.1018
2014	Turkey	0.0059	3.0941

The age reading from otoliths, judging by the differences in average weight-at-age in determining the age of fish older than two years, shows large discrepancies among countries in 2013 and 2014.

5.2.7.3 Maturity

In the population of the Black Sea whiting, maturation of males takes place on the first and second year of life, and that of females - after age 1 (Svetovidov, 1964 Shlyakhov, 1983). For the purposes of stock assessment female maturity ogives are commonly used. In previous assessments EWG took into account the data of Romania and Ukraine for ages 0 + - 0%, 1 - 75%, 2 and older - 100% (Fig. 5.2.7.3.1).

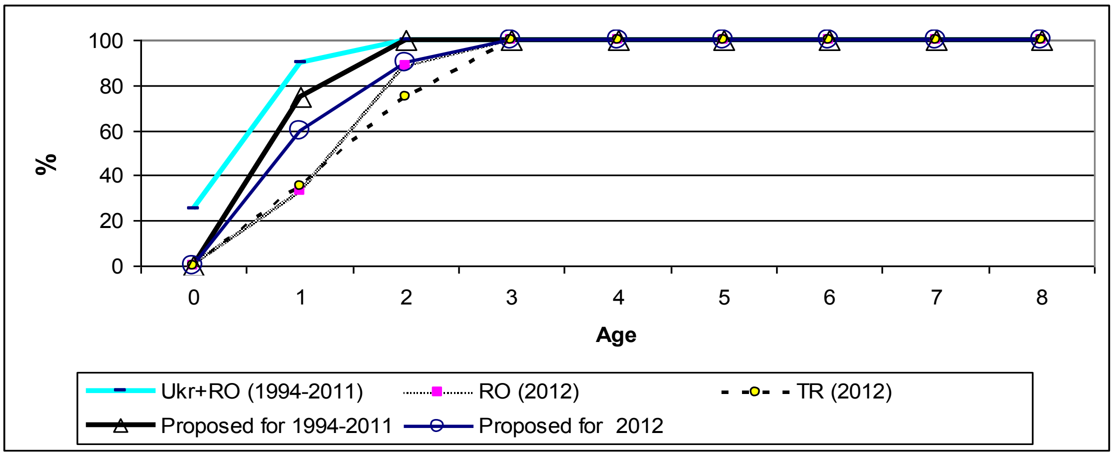


Fig. 5.2.7.3.1. Whiting in GSA 29. Maturity at age in 1994-2013.

According to the data of Romanian and Turkish scientists, the whiting rate of maturation of females in 2014 was slower than in previous years.

5.2.7.4 Natural mortality

There are some old studies that report M estimation for whiting in the Black Sea.
Prodanov et al. (1997) cite the mean value of M in the range of 0.65-0.70 as reported by Prodanov (1984), and the mean values of total mortality for fully represented age groups were reported in table 5.2.7.4.2.

Table 5.2.7.4.1. Whiting in GSA 29. Instantaneous rate of natural mortality by age (Prodanov et al.,1997).

Age	2	3	4	5
M	0.6592	0.8063	1.0241	0.9767

Shlyakhov (1983) calculatted the natural mortality of the Black Sea whiting for the period of total absence of its fisheries in the waters of the former Soviet Union (1975-1977). He applied three different methods: Beverton-Holt M = Z = k (L ∞ - l') / (l'-l1) = 0.72; Robson-Chapman M = Z = ln (1 + t'-1 / n) - ln t '= 0.74 and Gulland M = Z = - (ln Nt +1 - ln Nt) = 0.73. In 2014, the Pauly's formula was used to calculate natural mortality in both Turkey and Romania (Table 5.2.7.4.2).

Table 5.2.7.4.2. Whiting in GSA 29. Instantaneous rate of natural mortality by country estimated using 2014 data.

	Turkey	Romania
M	0.291	0.584

5.2.7.5 Fisheries

5.2.7.5.1 General description of the fisheries

In Black Sea, Turkey is the only country where the whiting is a target for the fisheries, and although its continental shelf does not exceed 10% of the entire Black Sea, since the nineties more than 90% of the whiting's Black Sea catches are landed by Turkey.

The whiting fishing fleet grew significantly after 1990 also targeting other demersal fishes, but since they also operate as mid-trawl vessels by changing gear equipment depending on actual fish movements and follow the schools of pelagic species it is difficult to assess the number of boats for this fishery. At present official records report over one hundred of bottom trawls operating in Samsun Shelf Area. According to Zengin et al. (1998) there are four fishing methods for whiting along Black Sea coasts off Turkey: trawl nets (82.1%), gill nets (13.6%), purse seines (3.7%) and lines (0.6%). The mean lengths of these catches range between 16 and 20 cm (of 16.1, 18.2, 16.0 and 19.6 cm respectively).

5.2.7.5.2 Management regulations applicable in 2015

The general management criteria announced by General Directorate of Fisheries for 2012 - 2014 (Anonymous, 2012) are described below and summarized in the Table 5.2.7.5.2.1.

Table 5.2.7.5.2.1. The current recommended of parameters for fisheries regulation on the whiting stocks along the Turkish Black Sea.

Regional area (Black sea)	Southern coasts (Turkey)
Official mesh size for bottom trawl	40 mm
Legal landing size (TL)	13.0 cm
First maturation size (TL50%)	14.5 cm
Scientifically recommended minimum catch length (cm)	15.0 cm
Scientifically recommended mesh size for bottom trawl	44 mm

(1) Area closures: The whiting fishery with bottom trawls is prohibited along waters a) between Sinop city, İnceburun (42° 05.959′ N-34° 56.695′ E) and Samsun city, Yakakent, Çayağzı Cape (41° 41.040′ N-35° 25.193′ E), b) between Ordu city, Unye; Taskana Cape (41° 08.725′ N-37° 17.531′ E) and Georgia border, c) between Ereğli Baba Cape (41° 17.342′ N-31° 23.937′ E) and Bartın city, Amasra, Tekke Cape (41° 43.485' N-32° 19.258' E) in 2 miles from land. Furthermore, in open areas it is prohibited to conduct any fishing within 3 miles from land (Fig. 5.2.7.5.2.1).
(2) Time closures: In open areas, the whiting fishery was prohibited from 15 April-15 September.
(3) Mesh size limitations: The mesh size should not be lower than 40 mm.
(4) Minimum legal catch size: For all kind of fisheries minimum legal size (total length) is 13 cm.

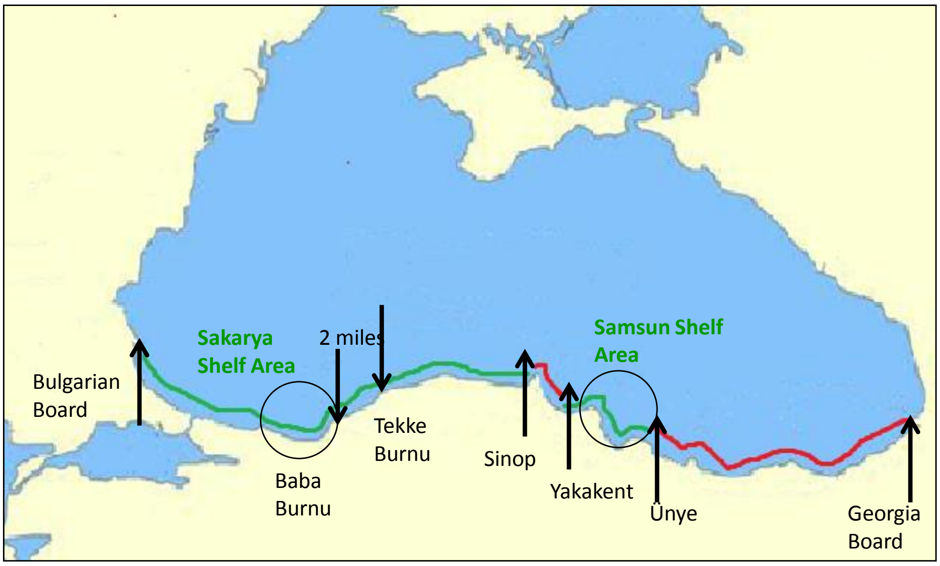


Fig. 5.2.7.5.2.1. Area closures and limitations for distance from land for bottom trawling along Turkish coasts (Green lines: open areas, red lines: area closures).

In Romania and Bulgaria, according amendments to EU Regulation 1343/2011 (article 15 a) fishery is allowed within three nautical miles from the coastline but below the isobaths of 50 meters. According to this regulation the prohibited area are shown in Fig. 5.2.7.5.2.2 for the Romanian coast. Table 5.2.7.5.2 shows the allowed minimum landing fish size for whiting in the Black Sea.

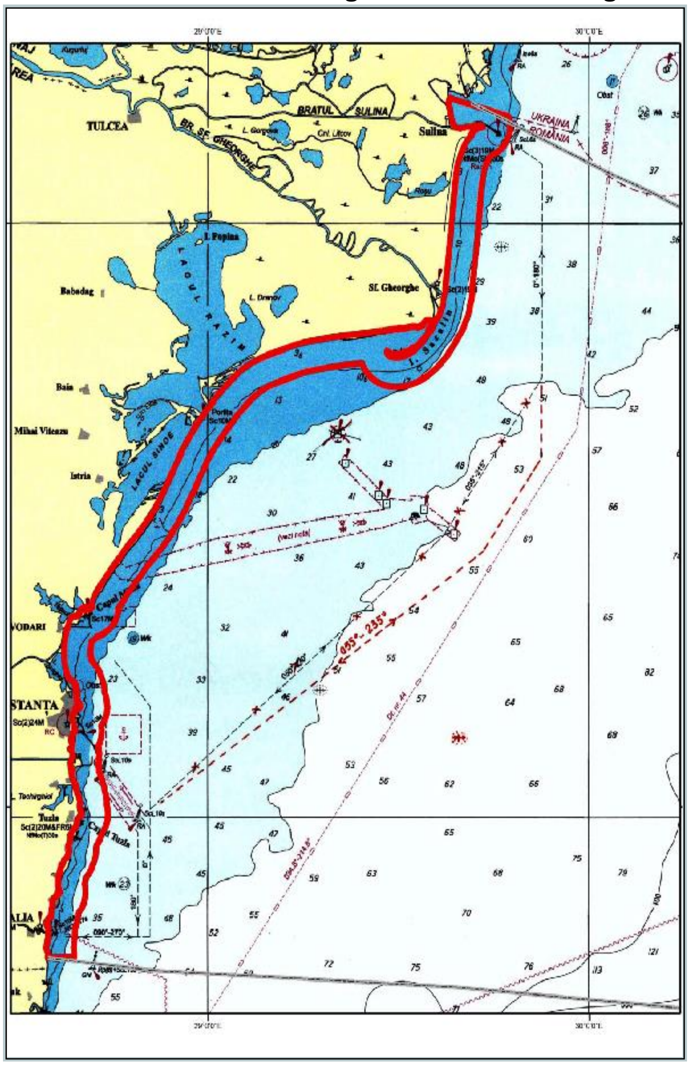


Fig. 5.2.7.5.2.2. Areas of closure and limitations for trawling along Romanian coasts.

Table 5.2.7.5.3. Whiting in GSA 29. Minimum landing size (Total length in cm) by country.

	BG	GE	RO	RU	TR	UA
whiting	8	2	7	12	13	12

For gill net fishery targeting whiting there is no limitation in mesh size but fishermen generally use the 32 mm mesh size. In recent years by the decrease in mean individual size the use of 28 mm mesh size has started. Zengin (2012) noted that in relation with the decrease in landings of whiting in the last three decades a clear negative gradient in mesh size of gill nets occurred with ten year intervals (Fig. 5.2.7.5.2.3).

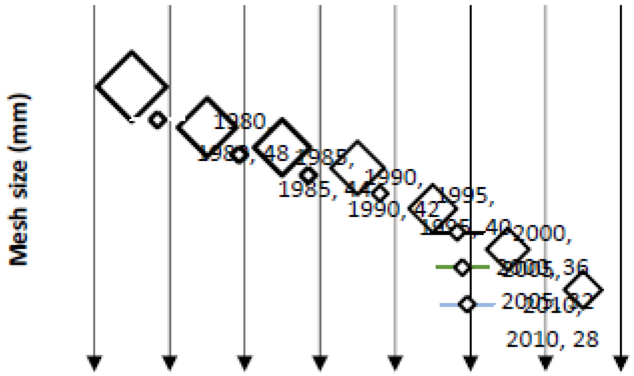


Fig. 5.2.7.5.2.3. The change in mesh size of gill nets used in whiting fishery in the last three decades (Zengin, 2012).

5.2.7.5.3 Catches

The following table lists the whiting catches in the Black Sea in the period 1980 - 2014 (Table 5.2.7.5.3.1).

Table 5.2.7.5.3.1. Whiting in GSA 29. Catches (tons) by countries.

Year	Bulgaria	Georgia	Romania	Russian Fed.	Turkey	Ukraine	Former USSR	Black Sea countries
1980	3890	0	618	0	6838	3882	5500	16846
1981	2564	0	894	0	4669	6053	6500	14627
1982	2754	0	800	0	4264	7511	8200	16018
1983	1507	0	1080	0	11696	6236	7800	22083
1984	1711	0	1192	0	11595	7993	10500	24998
1985	1501	0	3138	0	16036	3417	5000	25675
1986	1118	0	1949	0	17738	4007	4800	25605
1987	1058	0	615	0	27103	2315	4500	33276
1988	886	5	1009	736	28263	3759	4500	34658
1989	745	5	2739	7	19283	5993	5404	28767
1990	359	0	2653	235	16259	8565	8408	28001
1991	246	0	59	210	18956	2600	2284	21779
1992	483	70	1357	37	17923	900	0	20770
1993	620	172	599	16	17844	500	0	19751
1994	0	187	432	125	15084	400	0	16228
1995	0	146	327	91	17562	600	0	18726
1996	0	223	389	11	20326	1100	0	22049
1997	0	58	441	10	12725	1000	0	14234
1998	0	53	640	119	11863	1000	0	13675
1999	0	41	272	184	12459	650	0	13606
2000	9	37	275	341	15343	950	0	16955
2001	8	32	306	642	7781	1000	0	9769
2002	16	37	85	656	7775	1800	0	10369
2003	13	45	113	93	7062	21	0	7347
2004	2	29	118	55	7243	43	0	7490

Year	Bulgaria	Georgia	Romania	Russian Fed.	Turkey	Ukraine	Former USSR	Black Sea countries
2005	3	30	93	78	6637	30	0	6871
2006	2	37	97	60	7797	15	0	8008
2007	16	41	17	22	11232	64	0	11392
2008	0	15	55	96	10986	9	0	11162
2009	2	15	40	52	8979	17	0	9105
2010	15	15	24	23	11894	17	0	11987
2011	1	42	27	21	8122	36	0	8249
2012	1	42	15	3	6251	34	0	6346
2013	5	42	19	15	8240	20	0	8341
2014	4	0	10	1	8805	0	9	8819

5.2.7.5.4 Landings

Table 5.2.7.5.4.1 lists the whiting landings over the period 1970-2014. Due to the illegal fishery and numerous infringements through time and area, mesh size applications and increase in fishing effort a remarkable decrease in Turkish landings of whiting caught by bottom trawls occurred in last two decades. A decrease in total landings from 16.3 to 8.1 thousand tons occurred from 1990 to 2014. Further the mean total length of whiting's landings decreased from 19.7 cm to 8.9.

Table 5.2.7.5.4.1. Whiting in GSA 29. Landings (tons) by countries (FAO Fisheries Statistics, GFCM Capture Production 1970 – 2008, 2009 – 2014 from National Fisheries Statistics of countries).

Year	Bulgaria	Georgia	Romania	Russian Fed.	Turkey	Ukraine	Former USSSR/Crimea	Black Sea
1970	-	.	115	.	4312	.	.	4427
1971	-	.	442	.	5855	.	.	6297
1972	-	.	416	.	5284	.	.	5700
1973	-	.	329	.	2476	.	.	2805
1974	-	.	1305	.	2844	.	.	4149
1975	454	.	346	.	3913	.	.	4713
1976	347	.	541	.	4213	.	.	5101
1977	218	.	1495	.	5726	.	.	7439
1978	407	.	1345	.	21265	.	531	23548
1979	71	.	1205	.	20778	.	11377	33431
1980	30	.	618	.	6838	1102	2690	11278
1981	1	.	894	.	4669	2083	2238	9885
1982	4	.	800	.	4264	825	1513	7406
1983	0	.	1080	.	11696	817	2381	15974
1984	0	.	1192	.	11595	2252	4738	19777
1985	0	.	3138	.	16036	1101	2655	22930
1986	0	.	1949	.	17738	1867	2652	24206
1987	0	.	615	.	27103	579	2764	31061
1988	0	5	1009	736	28263	1482	2223	33718
1989	0	5	2739	7	19283	584	-	22618
1990	0	0	2653	235	16259	87	-	19234
1991	0	0	59	210	18956	24	-	19249
1992	0	70	1357	37	17923	0	-	19387
1993	0	172	599	16	17844	4	-	18635

Year	Bulgaria	Georgia	Romania	Russian Fed.	Turkey	Ukraine	Former USSSR/Crimea	Black Sea
1994	0	187	432	125	15084	64	-	15892
1995	0	146	327	91	17562	17	-	18143
1996	0	223	389	11	20326	3	-	20952
1997	0	58	441	10	12725	29	-	13263
1998	0	53	640	119	11863	55	-	12730
1999	0	41	272.4	184	12459	18	-	12974
2000	9	36.5	275	341	15343	20	-	16025
2001	8	32	306	642	7781	18	-	8787
2002	16	37	85	656	7775	9	-	8578
2003	13	45	113.4	93	7062	21	-	7347
2004	2	29	117.6	55	7243	43	-	7490
2005	3	30	93.3	78	6637	30	-	6871
2006	2	37	96.7	60	7797	15	-	8008
2007	16.1	41	17.1	22	11232	64	-	11392
2008	0.4	15	55.2	96	10986	9	-	11162
2009	2.3	15	39.5	52	8979	17	-	9105
2010	14.7	15	23.6	23	11894	17	-	11987
2011	1	42	0.1	20.9	8122	36	-	8222
2012	1.4	42	0.4	2.8	6251.4	34	-	6332
2013	5.3	-	1.1	15	8240	19.8	-	8281
2014	4.8	0	0.3	0.6	8805	0	9.1	8820

5.2.7.5.5 Discards

Since the mid-1970s to the early 1990s in the waters of Bulgaria and the former USSR studies to assess by-catch of whiting in the trawl fishery sprat were performed (Prodanov et al, 1997). Part of by-catch was discarded into the sea, and the rest labelled as "sprat" (fraction of sprat in such landings usually exceeded 90-95%). In any case, captured whiting was almost never reported in official fishing statistics. Although some of the whiting catch was landed (under the label of sprat), it could only be formally considered as by-catch, and in fact acted as a "discard". In Prodanov et al. (1997), no sampling was done to determine discard by ages, but it was known that discarding applied mainly to whiting aged less than two years. In the waters of Bulgaria in 1976-1987 whiting discards were at the highest and annually exceed 1,000 tons, maximum – 3860 tons (Table 5.2.7.5.5.1). In the absence of official landings of whiting in 1982-1993, discard was assumed to be 100%.

Table 5.2.7.5.5.1. Whiting in GSA 29. Discard in the trawl fisheries for sprat of Bulgaria and former USSR in the Black Sea in 1975-1993.

	Bulgaria		USSR	
Year	Discard, tons	Discard, %*	Discard, tons	Discard, %*
1975	300	39.8	N.A.	N.A.
1976	1338	78.0	85	79.5
1977	1917	89.8	800	100
1978	2506	86.0	2700	82.2
1979	2493	97.2	6500	36.4
1980	3860	99.2	2780	50.5
1981	2563	100	3970	61.1
1982	2750	100	6686	81.5

	Bulgaria		USSR	
Year	Discard, tons	Discard, %*	Discard, tons	Discard, %*
1983	1507	100	5419	69.5
1984	1711	100	5741	54.7
1985	1501	100	2316	46.3
1986	1118	100	2140	44.6
1987	1058	100	1736	38.6
1988	886	100	2277	50.6
1989	745	100	5409	90.2
1990	359	100	8478	96.3
1991	246	100	2576	99.1
1992	483	100	900	100
1993	620	100	500	100

* calculated as the percentage of discard compared to the total official catches of whiting

In Ukrainian waters the largest by-catch and discard of whiting was in 1978-1991 (1.7-6.7 thousand tons annually). Sampling whiting bycatch-at-sea during 1992-2002 in Ukrainian waters was conducted (Shlyakhov, Charova, 2006). Estimates are based on the monitoring of data extracted in the process of sprat fisheries on board fishing vessels. In Ukrainian waters target fisheries for whiting and sprat with midwater trawls are permitted approximately at 60% of the shelf zone. As sprat trawl fisheries are more profitable for economic reasons, fishermen try to conduct fishing in areas of the densest concentrations, occurring usually in depth ranges of 30-60 m and less. Between 1990-1994 and 2005-2009 an Ukrainian shift of the trawl fishery towards shallow coastal waters has occurred (Shlyakhov, Shlyakhova, 2011)(Table 5.2.7.5.5.2). This process was accompanied by an increase in the discard of whiting aged 0 + and 1 with respect to total landings (Table 5.2.7.5.5.3). For the period 1994-2002 the relative mean value of whiting total caches discarded in Ukrainia varied from 2.2% to 12.5% of the total catches of all Black Sea's countries.

Table 5.2.7.5.5.2. Whiting in GSA 29. Discard in the trawl fisheries for sprat in Romania and Ukraine in 1975-1993.

	Romania		Ukraine	
Year	tons	%	tons	%
1994	N.A.	N.A.	336	84.0
1995	N.A.	N.A.	583	97.2
1996	N.A.	N.A.	1097	99.7
1997	N.A.	N.A.	971	97.1
1998	N.A.	N.A.	945	94.5
1999	N.A.	N.A.	632	97.2
2000	N.A.	N.A.	930	97.9
2001	N.A.	N.A.	982	98.2
2002	N.A.	N.A.	1791	99.5
2003-2010	N.A.	N.A.	N.A.	N.A.
2011	0.1	99.6	N.A.	N.A.
2012	0.4	97.3	N.A.	N.A.
2013	N.A	19.9	N.A	N.A

Table 5.2.7.5.5.3. Whiting in GSA 29. Percentage discard rate by age class and year in 1994-2013 (1994 - 2002 – data from midwater trawl sprat fishery for Ukrainian waters, 2011 - 2013 – data from pound nets fishery for Romanian waters, 2003 - 2010 – data not available).

AGE	0	1	2	3	4	5	6
1994	3.13	1.00	1.64	0.07	0.69	10.61	100.00
1995	4.08	1.57	7.73	0.98	2.21	0.64	1.58
1996	7.88	2.58	2.16	2.38	3.63	6.10	5.12
1997	7.74	7.58	2.66	2.70	35.47	93.84	100.00
1998	20.53	5.60	5.60	5.60	5.60	5.60	46.57
1999	14.61	4.36	3.35	3.27	3.33	4.28	58.13
2000	31.17	3.03	3.03	4.13	1.76	3.96	1.37
2001	18.20	12.43	4.09	4.09	5.55	2.39	3.36
2002	88.68	43.80	15.37	3.01	0.98	0.52	0.41
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	1.22	0.78	0.43	0.18	0.29	0.04	0.00
2012	37.10	3.04	0.38	0.00	0.00	0.00	0.00
2013	39.20	3.65	0.42	0.00	0.00	0.00	0.00

In 2012, for the first time were presented to the EWG the Bulgarian (1975-1993) and Ukrainian (1976-2002) data on discarded whiting in the trawl fishery for sprat, the Turkish (2005-2011) and Romanian (2011-2013) data on discards in the target whiting fishery. These data show that discards are an important part of the whiting catches in ages 0 + and 1, and therefore they should be included in the data set for stock assessment. However, this seems impossible because of the incomplete data for discards by age in 1994-2002 and 2011-2012, and the total absence in 2003-2010.

5.2.7.5.6 Fishing effort

No quantitative information on fishing effort was available during the EWG 15-12 meeting.

5.2.7.6 Scientific surveys

5.2.7.6.1 Survey

5.2.7.6.1.1 Methods

In the EWG 15-12 only Romania and Turkey presented data on scientific surveys in 2014. The swept area method was applied to estimate density and biomass indices of whiting (Table 5.2.7.6.1.1).

Table 5.2.7.6.1.1. Whiting in GSA 29. CPUE of different trawl surveys conducted in the Black Sea in the 2014.

Country	Season	hauls	Total catch (kg)	Mean haul duration (minutes)	CPUE (kg/h)	t/Nm^2	10^{-3} fish
Romania	Spring	41	782.26	60	19.07	1.115	
Romania	Autumn	40		40	1.95	0.111	594.23
Turkey	Summer	16	909	30	24.23		

The Romanian survey was carried out in spring and autumn 2014 using a trawl net of 13 m in horizontal opening and 22/27 mm of mesh size. The main information are reported on table 5.2.7.6.1.1.2.

Table 5.2.7.6.1.2. Main features of the Romanian demersal trawl survey conducted in 2014.

Season/hauls	Spring, May June 2014 (41 hauls)				Autumn, November (40 hauls)			
Depth range (m)	0–30	30–50	50-70	Total	0–30	30–50	50-70	Total
Investigated area (Nm^2)	625	1150	825	2600	625	1150	875	2650
Range of catches (t/ Nm^2)	0-7.41	0-5.7	0-5.7	0-7.41	0	0-0.114	0-2.85	0-2.85
Average catch (t/ Nm^2)	1.82	1.473	0.466	1.114	0	0.019	0.311	0.111
Biomass of fishing aggregations (t)	1140.4	1694.56	385.15	2898.3		22.95	272.49	294.65
Total biomass (shelf, t)				5573.7				555.95

The Turkish survey was carried out (August 2014) along the coast from Samsun to the Georgian border in the framework of the project “Investigation of Opportunities on Cultivation of Gurnard (*Chelidonichthys lucerna* L., 1758)”. The trawl net used had a vertical height of 12 m, horizontal opening 22.5 m, a 14*12 mm mesh size. Hauls duration were fixed to 30 minutes.

5.2.7.6.1.2 Geographical distribution

The seasonal geographical pattern distribution of whiting is given in for Romanian (figure 5.2.7.6.1.2.1) and Turkish waters (figure 5.2.7.6.1.2.2).

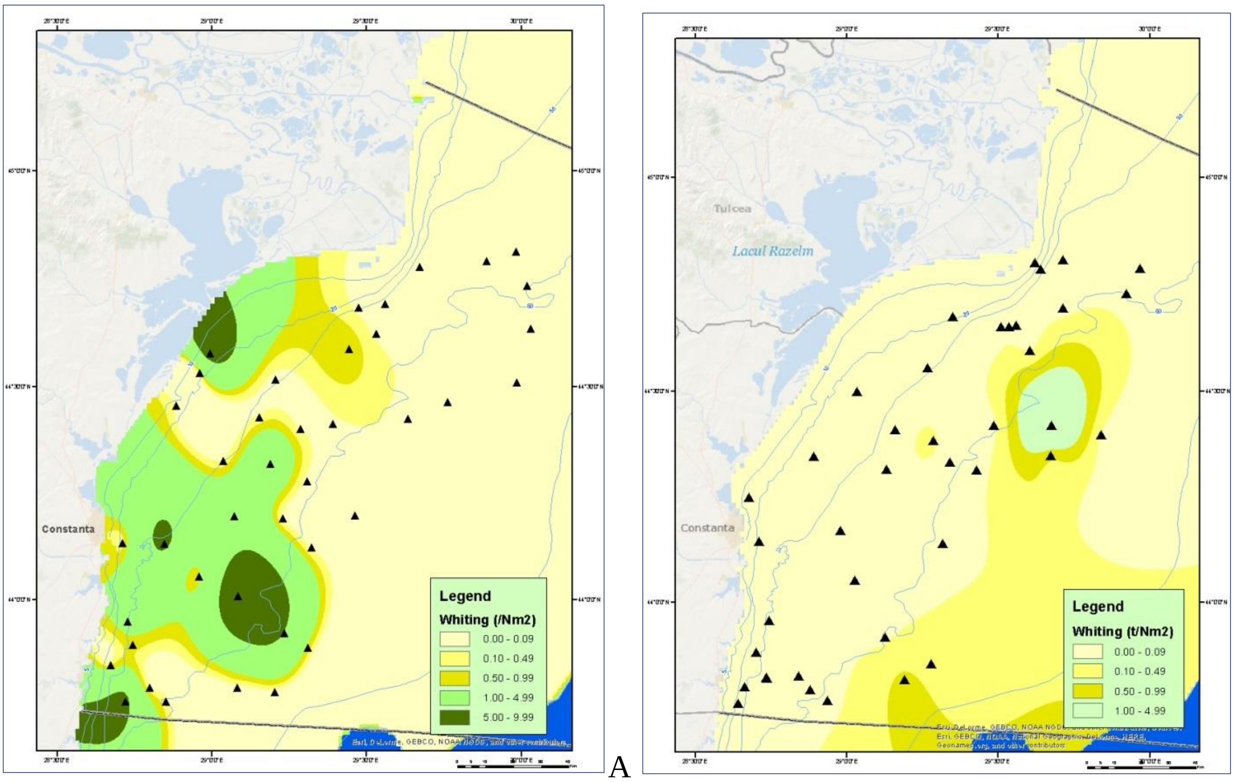


Fig. 5.2.7.6.1.2.1. Whiting in GSA 29. Distribution along the Romanian littoral (year 2014, A=spring, B=autumn).

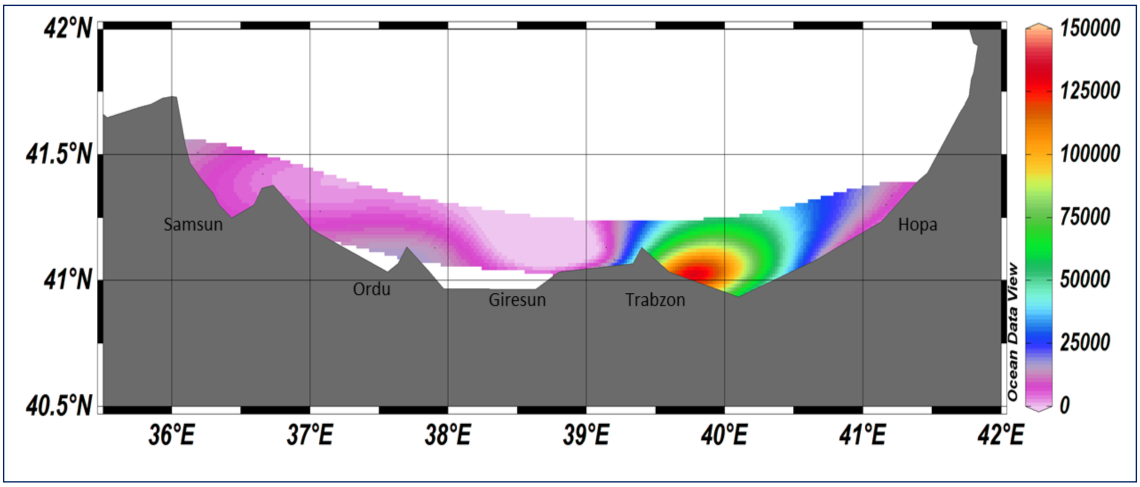


Fig. 5.2.7.6.1.2.2. Whiting in GSA 29. Distribution along the Turkish littoral (August 2014).

5.2.7.6.1.3 Trends in abundance and biomass

Results for estimated whiting biomasses and abundance in spring and autumn of 2014 in Romanian waters are given in Tables 5.2.7.6.1.3.1 and 5.2.7.6.1.3.2.

Table 5.2.7.6.1.3.1. Whiting in GSA 29. Trend of abundance indices by age according to the Romanian trawl surveys in 2007-2014 (10^6).

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Total
2007	47.33	989.39	449.26	66.06	0.00	0.00	1552

2008	71.27	961.93	401.44	41.10	0.00	0.00	1476
2009	85.34	431.12	286.88	65.12	18.17	0.00	887
2010	207.06	1145.08	483.52	51.51	14.56	0.00	1902
2011	452.01	1152.96	791.57	72.78	7.46	8.69	2485
2012	10.08	612.63	252.23	33.36	0.00	0.00	908
2013	568.89	1491.60	1107.72	240.51	57.81	0.00	3467
2014	48.56	275.28	276.56	97.10	25.11	0.00	723

Table 5.2.7.6.1.3.2. Whiting in GSA 29. Survey CPUE (kg/h) between 2011 to 2014 in the Samsun shelf area (SSA) and West Turkish Black Sea.

Region	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	102	0	150	31.03	2.72	27.46
CPUE/SSA (EBS)	60	0	150	30.59	3.64	28.2
CPUE/ WBS	42	0	100	31.66	4.12	26.69

Table 5.2.7.6.1.3.3. Whiting in GSA 29. Trend of abundance indices (N×10^{-3}) and average CPUE (kg/h) by age according to the Turkish trawl surveys in 2009 – 2014.

Age	0	1	2	3	4	5	6	7	8	Total	Kg/h
2009	1015	232.4	438.7	138	31.6	3.7	0	0	0	1859.1	212.7
2010	14.4	507.1	768.1	244	52.5	9.3	0	0	0	1595.5	56.7
2011	115.6	765.1	852.4	352	50	26.5	0	0	0	2161.5	52.1
2012	12	276	558.2	217	27.9	17.5	1.9	0	0	1111.3	31
2013											
2014	22.81	465.84	73.49	2.49	2.96	2.53	1.69	0	0	594.23	24.2

5.2.7.6.1.4 Trends in abundance by length or age

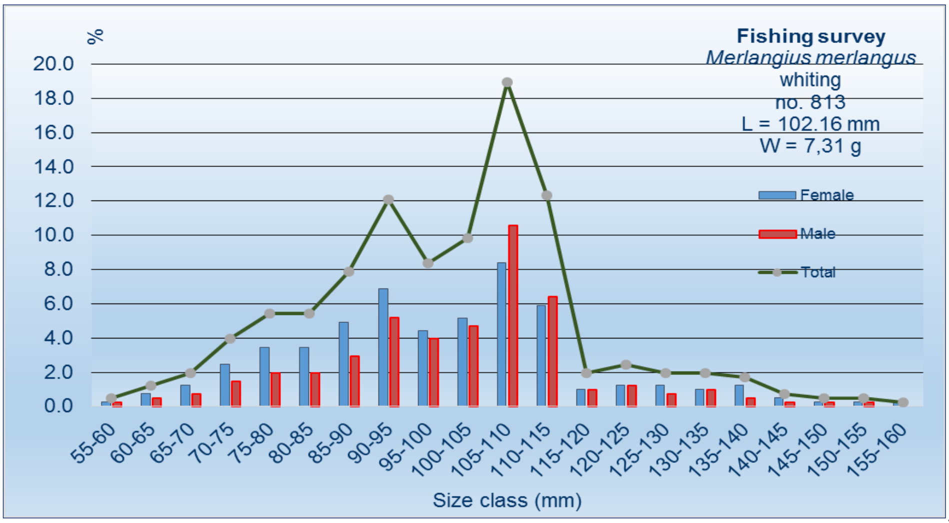
Results for estimated whiting abundance by length of 2014, in Romanian waters are given in Tables 5.2.7.6.1.4.1.

Table 5.2.7.6.1.4.1. Whiting in GSA 29. Indices of abundance by length according to the Romanian research trawl surveys in 2011 - 2014 (10^6).

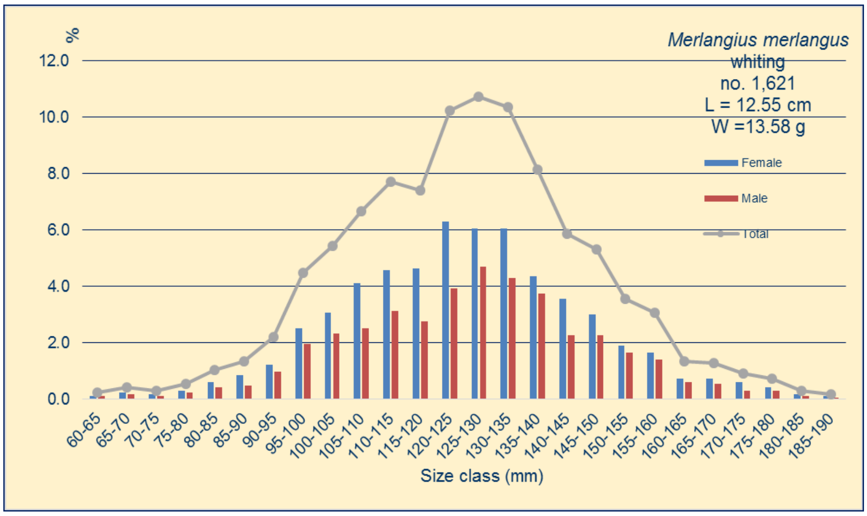
Class of length (cm)	2011	2012	2013	2014
4	1.2			
5	29.3	9.9	18.2	3.1
6	110.9	119.2	454.7	25.0
7	73.1	118.6	612.1	76.4
8	168.2	155.2	721.7	117.5
9	315.5	194.2	658.9	156.7
10	432.9	182.7	441.3	128.0
11	504.8	113.9	268.7	82.9
12	413.2	60.1	171.5	62.4

13	235.7	29.0	81.0	39.6
14	130.9	10.5	32.1	17.7
15	49.9	4.2	4.9	8.5
16	12.3	0.4	0.7	2.9
17	3.5	0.2	0.6	1.5
18	2.1	0.0	0.0	0.3
19	2.1	0.0	0.0	0.0
TOTAL	2485.5	998.3	3466.5	722.6

The length distribution (figure 5.2.7.6.1.4.1) and the age distribution (figure 5.2.7.6.1.4.2) from the Romanian survey are reported below.

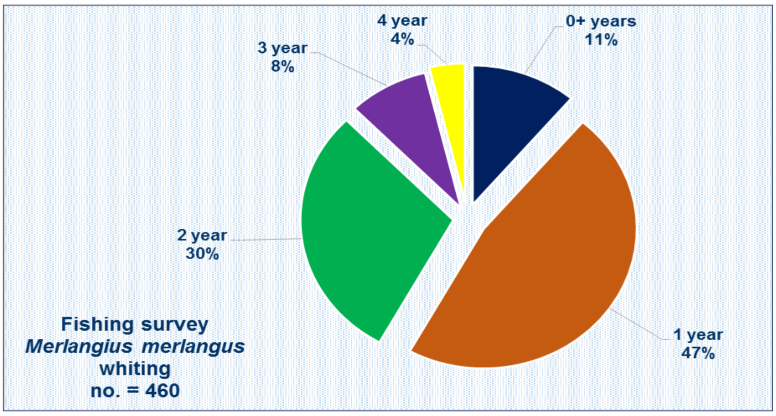


A

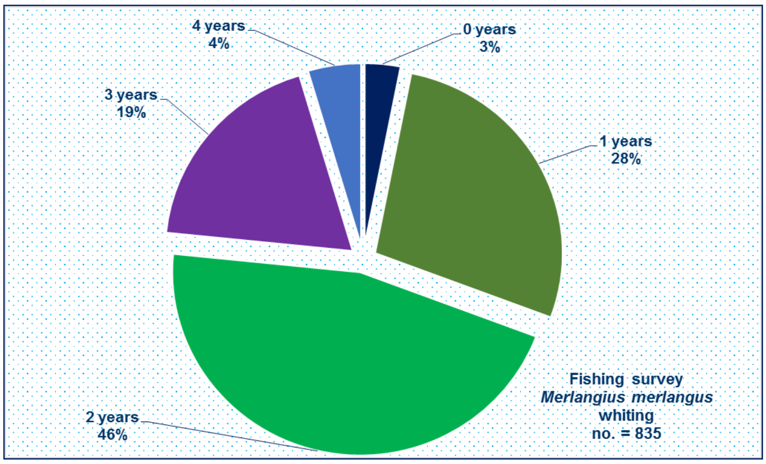


B

Fig. 5.2.7.6.1.4.1. Whiting in GSA 29. Length distribution by sex (A=spring, B=autumn) estimated by the Romania survey.



A



B

Fig. 5.2.7.6.1.4.2. Whiting in GSA 29. Age composition estimated from the Romanian trawl survey (A=spring, B=autumn).

5.2.7.6.2 Acoustic survey

5.2.7.6.2.1 Methods

Acoustic survey covers partially the territorial waters and EEZ of Bulgaria in FAO GSA 29 – Black Sea. The study area includes continental shelf and slope up to 200 m depth. Total investigated area amounts approximately to 2630 Nm^2.

5.2.7.6.2.2 Geographical distribution

Whiting was found mostly over the southern shelf area at depths between 40 and 60 m, where the sprat schools were concentrated. In the northern and central areas, the whiting schools were scarce or absent. The point map of the distribution of whiting NASC values obtained during the acoustic survey of R/V "Akademik" in 2014 is presented on the Fig. 5.2.7.6.2.2.1.

Whiting schools were dispersed and acoustically were registered in front of Durankulak – Shabla and Bourgas - Tsarevo. In the rest of the area whiting was not registered. Estimated relative abundance (millions) and biomass (tonnes) of whiting by age group and polygons are presented on Table 5.2.7.6.2.2.1 and Table 5.2.7.6.2.2.2.

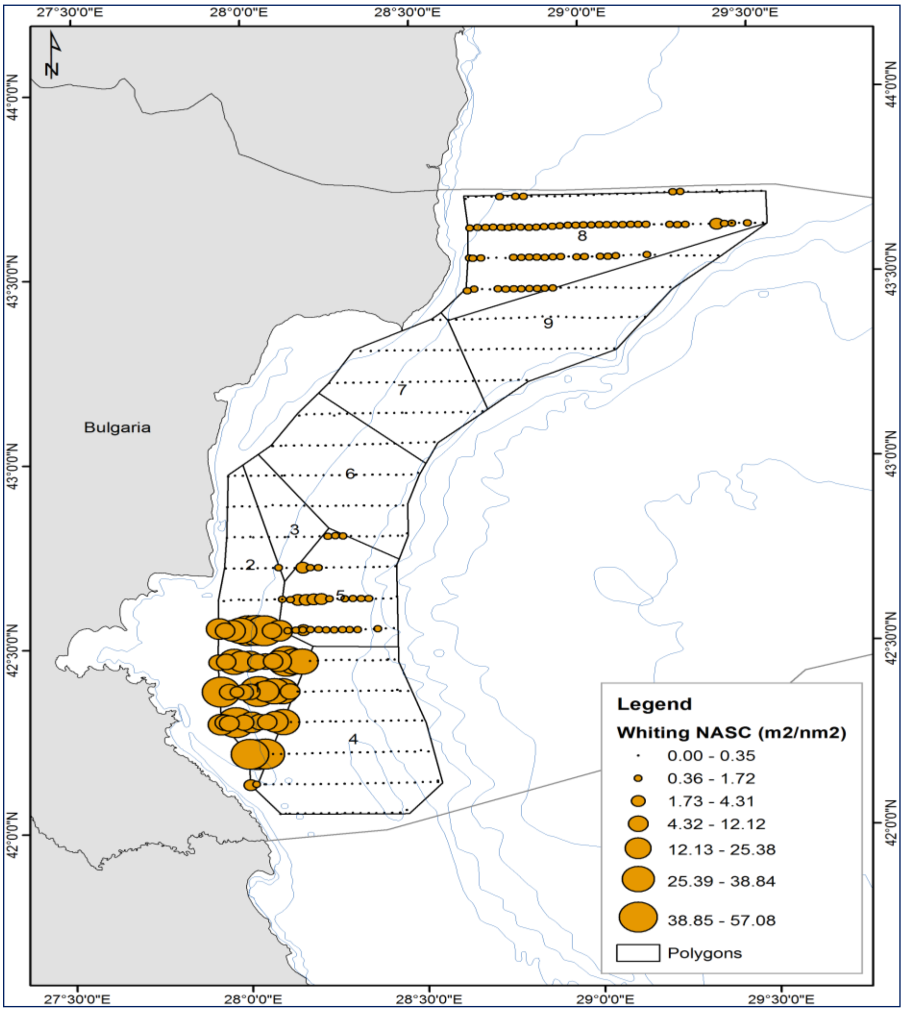


Fig. 5.2.7.6.2.2.1. Whiting in GSA 29. NASC values (m^2/Nm^{-2}).

5.2.7.6.2.3 Trends in abundance and biomass

Results for estimated whiting biomasses and abundance in October/November of 2014 in Bulgarian waters are given in Tables 5.2.7.6.2.3.1, and 5.2.7.6.2.3.2.

Table 5.2.7.6.2.3.1. Whiting in GSA 29. Abundance (10^3) by age classes and polygons, in 2014.

Polygon	Total (millions)	Age			
		1	2	3	4
1	1976.7	560.8	644.9	560.8	210.3
2	163.6	46.4	53.4	46.4	17.4
5	237.1	67.3	77.4	67.3	25.2
6	202.4	57.4	66.0	57.4	21.5
8	446.4	126.7	145.6	126.7	47.5
Total (millions)	3026.2	858.5	987.3	858.5	321.9

Table 5.2.7.6.2.3.2. Whiting in GSA 29. Biomass (tons) by age groups and polygons in 2014.

Polygon	Total (t)	Age			
		1	2	3	4
1	30560.6	8669.7	9970.1	8669.7	3251.1

Polygon	Total (t)	Age			
		1	2	3	4
2	2529.1	717.5	825.1	717.5	269.1
5	3666.1	1040.0	1196.0	1040.0	390.0
6	3128.6	887.5	1020.7	887.5	332.8
8	6901.9	1958.0	2251.7	1958.0	734.3
Total (t)	46786.3	13272.7	15263.6	13272.7	4977.3

5.2.7.6.2.4 Trends in abundance by length or age

No information on trends in abundance by length was available for MEDIAS survey during the EWG 15-12 meeting.

5.2.7.7 Stock Assessment

5.2.7.7.1 Methods

STECF EWG 15-12 conducted an assessment of the whiting stock in Black Sea using an Extended Survivors Analysis (XSA, Shepherd, 1992). The data (1994-2014) of landings, catch at ages, weights and maturity at age are considered appropriate for assessing the stock using XSA. Turkish CPUE and Romanian survey data were used for tuning the assessment.

5.2.7.7.2 Input data

Recent data from national statistics by countries in 2014 were added to the historic catch at age data set of GSA 29 (1994 – 2013) compiled during the previous meetings (Sampson et.al, 2014). The catch at age data was corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards. Due to weakly documented discarding rates of fish of 0 ages, it was deemed reasonable to exclude it from the XSA in order to reduce the bias introduced by the poorly documented discard rate. The assessment was thus ran using ages 1 to 6 for the both the catch matrix and the tuning indexes. The mean weights at ages in the stock for the period 1994-2014 were assumed equal to the catch weights at age in the landings due to lack of discard data. For 2013 and for 2014, weights at age were estimated as an arithmetic mean calculated across the countries (data available only for Turkey, Romania and Bulgaria).

Natural mortality (M) vector applied in all ages and years was constant and the same as assessment in 2014 (Sampson et.al., 2014). Maturity ogives applied are the same used in the assessment from 2014 (Sampson et. al., 2014). The XSA was tuned with 2 data series: commercial CPUE from Turkey (ages 0 – 6 over the period 2009 – 2014) and survey index from Romania (ages 0 – 4, over the period 2007 – 2014). In both series of data for some years the NAs values indicate that the last age class (6 and 4 respectively) have not been gathered. The exploration analysis of landing data series is presented in figures Fig. 5.2.7.7.2.1 and Fig. 5.2.7.7.2.2. As shown trend in catches by country are dominated by Turkey.

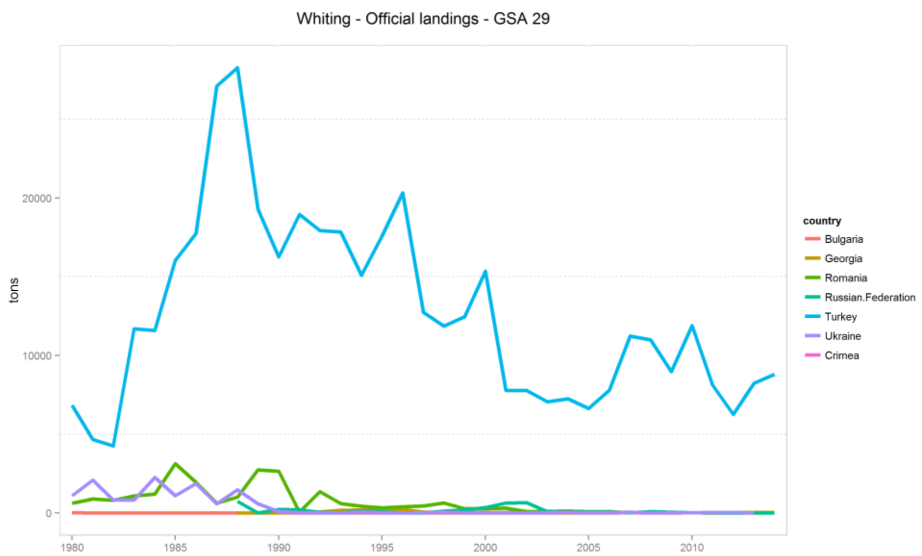


Figure 5.2.7.7.2.1. Whiting in GSA 29. Trends in catches by country (1980 – 2014).

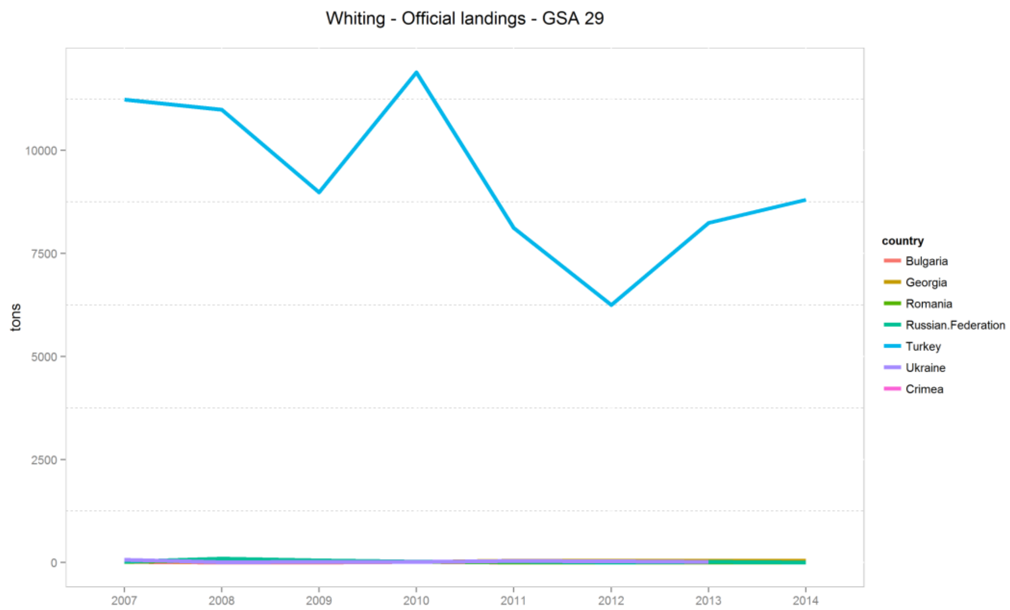


Figure 5.2.7.7.2.2. Whiting in GSA 29. Trends in catches by country (zoom for 2007 – 2014).

On figure 5.2.7.7.2.3, the exploration analysis of Turkish tuning series is presented. As showed, Romanian survey indices decrease in last year and the Turkish CPUE – keep the same trends as last years.

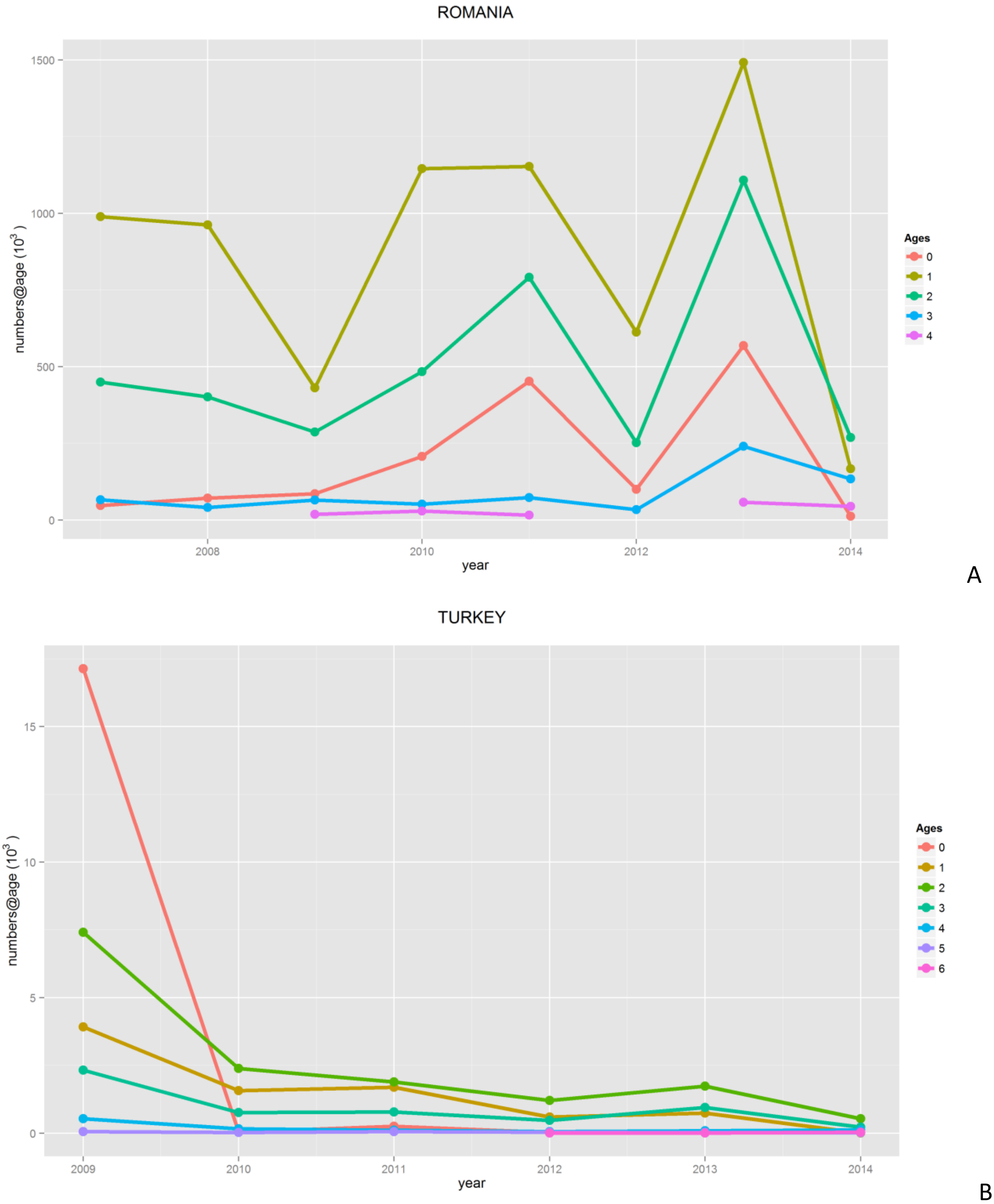


Figure 5.2.7.7.2.3. Whiting in GSA 29. A) Trends in the Romanian survey (2007 – 2014) and B) Turkish CPUE (2009 – 2014) series at age.

It is clear that the Turkish CPUE are low at age 0 and 1 (Fig. 5.2.7.7.2.4), while there are some inconsistences in older ages (Fig. 5.2.7.7.2.5).

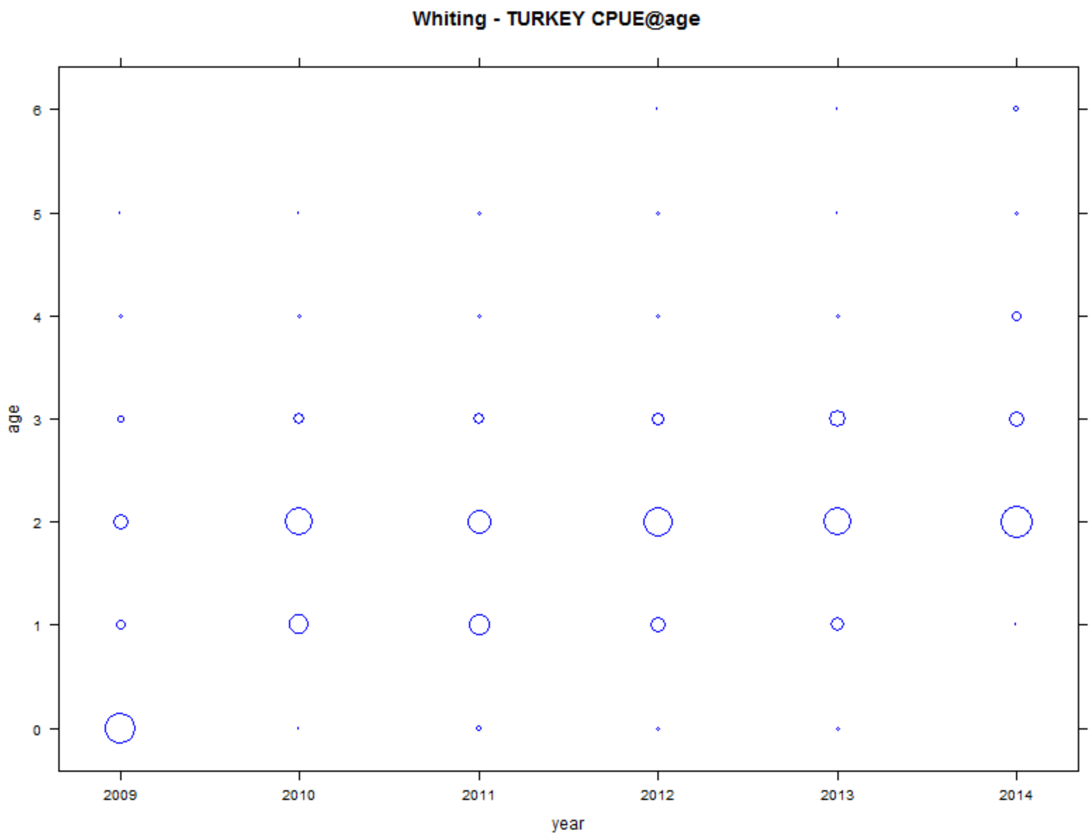
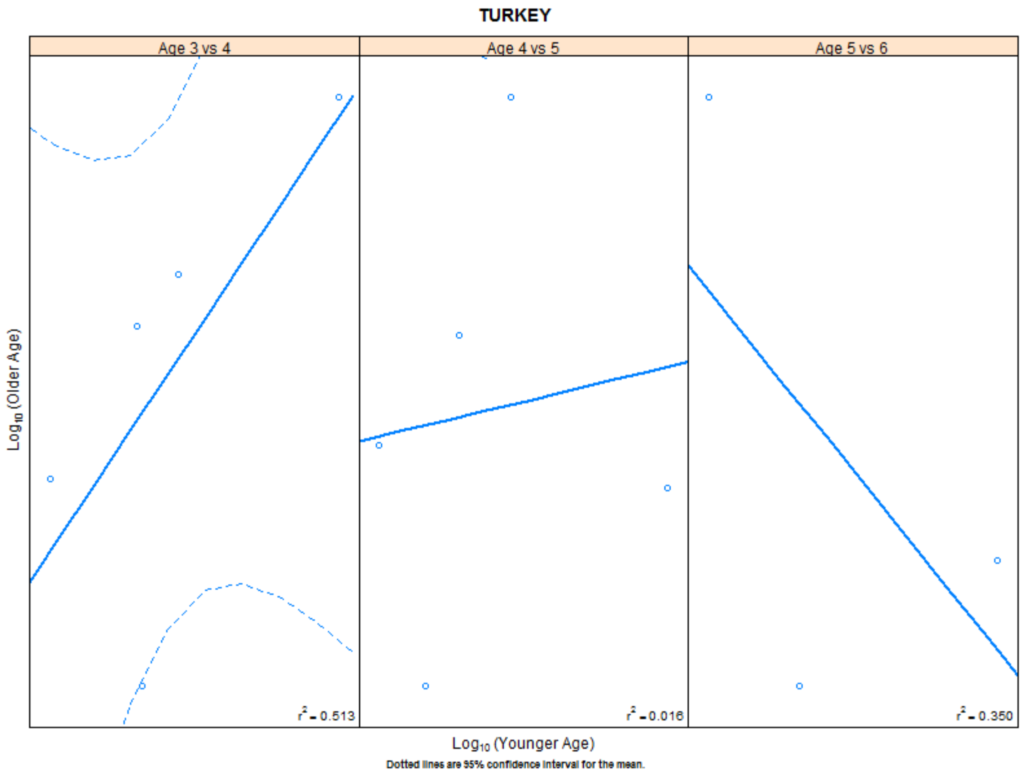
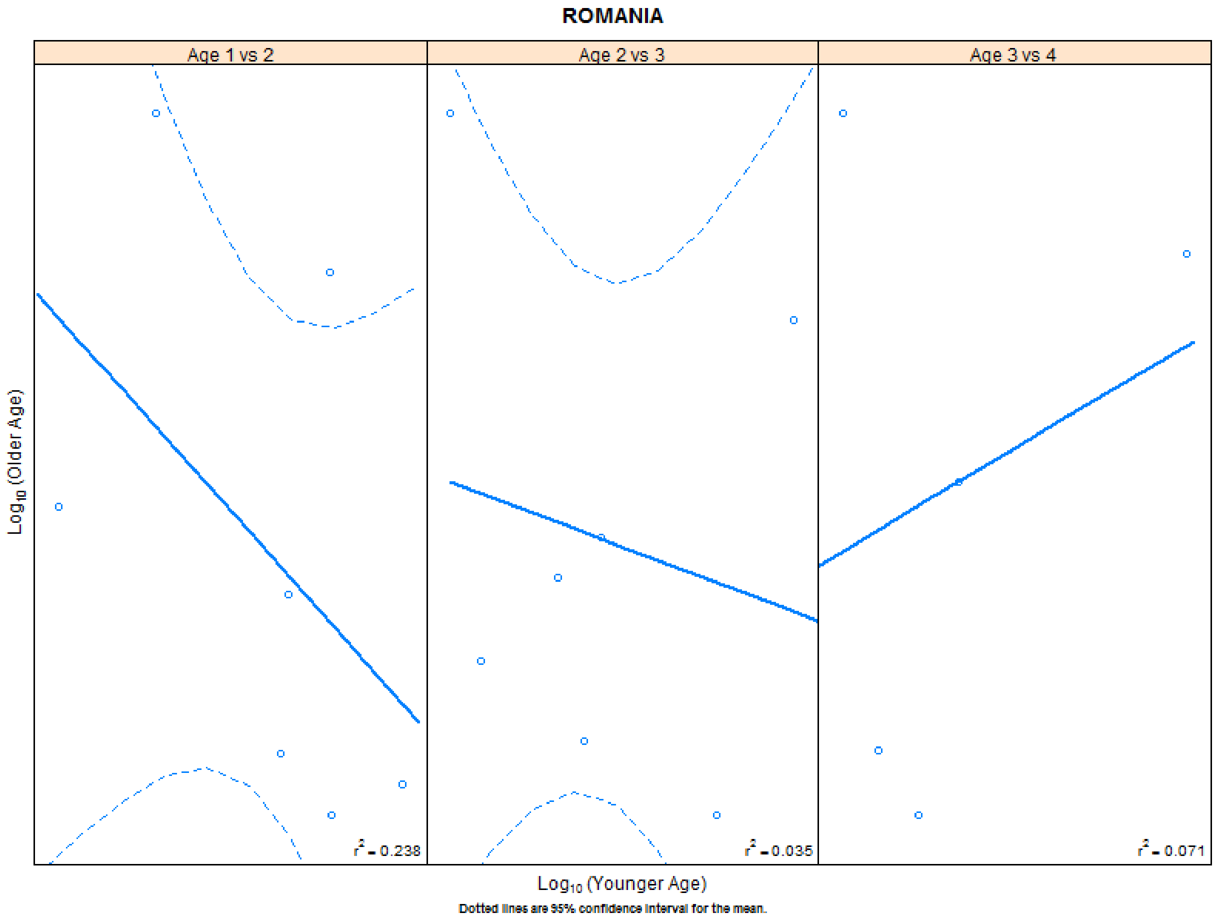
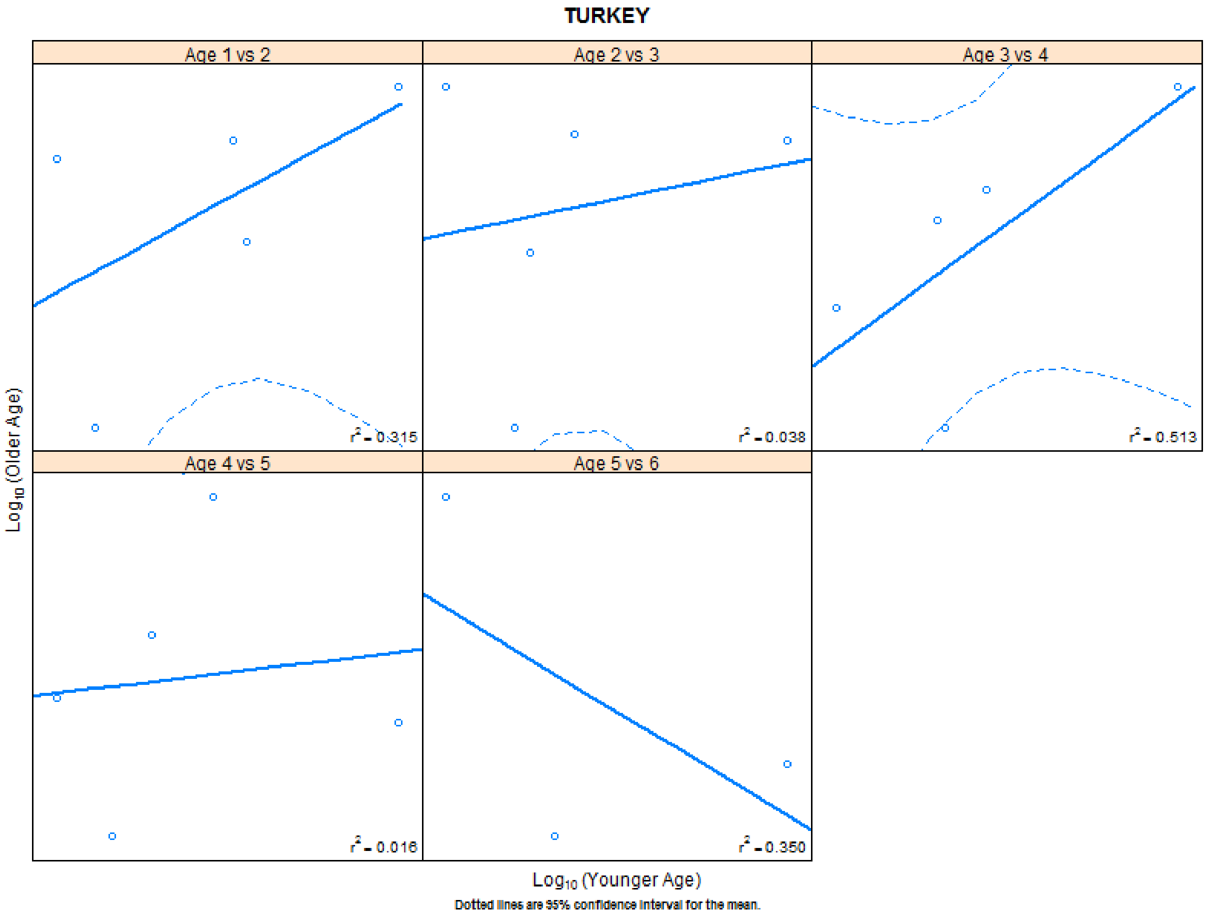


Fig. 5.2.7.7.2.4. Whiting in GSA 29. Turkish CPUE data at age over the period 2009 – 2014.




ROMANIA
Age 1 vs 2
Age 2 vs 3
Age 3 vs 4
Log10 (Older Age)
r2 = 0.238
r2 = 0.035
r2 = 0.071
Log10 (Younger Age)
Dotted lines are 95% confidence interval for the mean.

a



b

Fig. 5.2.7.7.2.5. Whiting in GSA 29. Internal consistency of Romanian (a) and Turkish (b) CPUE data (2009 – 2014).

The input parameter used for the assessment of whiting in GSA 29 are presented in table 5.2.7.7.2.1.

Table 5.2.7.7.2.1. Whiting in GSA 29. Input parameters for the XSA.

```
### TUNING
#  RO Trawl fleet
, , unit = unique, season = all, area = unique, iter = 1

   year
age     2007     2008     2009      2010      2011     2012      2013     2014
  1 989385.4 961931.8 431119.2 1145076.1 1152958.8 612631.2 1491599.6 166917.4
  2 449264.4 401438.8 286875.1  483516.7  791569.8 252230.2 1107715.1 269061.9
  3  66062.2  41102.6  65124.2   51510.2   72781.2  33361.1  240506.0 134311.5
  4       NA       NA  18168.8   29579.4   16148.8       NA   57813.9  44707.8

#  TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)
, , unit = unique, season = all, area = unique, iter = 1

   year
age   2009   2010   2011   2012   2013  2014
  1 3923.0 1573.6 1696.2  597.9  740.3   7.8
  2 7406.6 2383.7 1889.7 1209.0 1740.3 533.0
  3 2322.4  758.1  780.3  470.1  953.4 222.3
  4  533.5  162.9  110.7   60.4   85.6 120.7
  5   62.8   28.7   58.9   38.0   31.1  19.9
  6     NA     NA     NA    5.5    3.2  41.2


### initial settings
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        1         6         6      1994      2014         1         4

### Mortality and Maturity vectors@age
  age mortality maturity
1   1    0.2563      0.6
2   2    0.1163      0.9
3   3    0.0697      1.0
4   4    0.0464      1.0
5   5    0.0324      1.0
6   6    0.0230      1.0

### Mean Weight@age (kg) in stock, catch, landings
      age
year        1      2      3      4      5      6
  1994 0.0093 0.0204 0.0374 0.0692 0.0896 0.1236
  1995 0.0093 0.0204 0.0374 0.0692 0.0896 0.1422
  1996 0.0093 0.0204 0.0374 0.0692 0.0896 0.1422
  1997 0.0093 0.0204 0.0374 0.0692 0.0896 0.1236
  1998 0.0093 0.0204 0.0374 0.0692 0.0896 0.1416
  1999 0.0093 0.0204 0.0374 0.0692 0.0896 0.1416
  2000 0.0105 0.0219 0.0394 0.0681 0.0864 0.1221
  2001 0.0099 0.0206 0.0370 0.0651 0.0820 0.1221
  2002 0.0117 0.0232 0.0385 0.0611 0.0839 0.1422
  2003 0.0100 0.0210 0.0382 0.0562 0.0820 0.1221
  2004 0.0100 0.0211 0.0387 0.0558 0.0820 0.1220
  2005 0.0098 0.0198 0.0383 0.0574 0.0801 0.1198
  2006 0.0097 0.0204 0.0368 0.0591 0.0820 0.1222
  2007 0.0100 0.0203 0.0382 0.0581 0.0824 0.1285
  2008 0.0100 0.0204 0.0356 0.0604 0.0817 0.1182
  2009 0.0090 0.0191 0.0337 0.0564 0.0787 0.1097
  2010 0.0090 0.0186 0.0328 0.0553 0.0803 0.1236
  2011 0.0073 0.0161 0.0288 0.0431 0.0639 0.1236
  2012 0.0071 0.0171 0.0327 0.0526 0.0761 0.0707
  2013 0.0060 0.0135 0.0240 0.0390 0.0428 0.0627
```

```
  2014 0.0063 0.0119 0.0216 0.0320 0.0629 0.0910

### catch,landings, discards  in weight (ton) by year
   year     catch  landings discards
1  1994 12898.427 12898.427        0
2  1995 13716.852 13716.852        0
3  1996 17350.449 17350.449        0
4  1997  9488.510  9488.510        0
5  1998 11657.388 11657.388        0
6  1999 11861.788 11861.788        0
7  2000 14635.629 14635.629        0
8  2001  6711.347  6711.347        0
9  2002  8426.105  8426.105        0
10 2003  7074.499  7074.499        0
11 2004  6261.371  6261.371        0
12 2005  5421.395  5421.395        0
13 2006  7632.160  7632.160        0
14 2007 10805.002 10805.002        0
15 2008 10833.424 10833.424        0
16 2009  7546.166  7546.166        0
17 2010 11966.584 11966.584        0
18 2011  8146.743  8146.743        0
19 2012  6320.441  6320.441        0
20 2013  8308.066  8308.066        0
21 2014  8861.110  8861.110        0

### Catch at age matrix (numbers in thousands)
      age
year        1      2      3     4     5     6
  1994 518096 116890 113231 20878   329     3
  1995 766031  50537  86893 17296  9743  1826
  1996 782118 309733  61502 17221  1762   923
  1997 259929 245544  53085  1244     8     3
  1998 357804 218795  49764 25334  2838    67
  1999 441537 203064  45306 23357  3413    67
  2000 579380 202752  44165 23127  4392  3485
  2001 281528  98444  29563  6428  2816  1209
  2002  59109  73951  39589 36472 17476  5606
  2003  86545  84441  32468 26024 17850  2275
  2004  80058 144347  44896 10360  1198     2
  2005 319095  16318  38420  6095  1524   261
  2006 276059 154059  17607 10512  6086   303
  2007 342483 188068  36915 14710 11010  2973
  2008 329203 189612  36835 26664  7999   782
  2009 103226 192826  60364 13849  1629     2
  2010 199180 300588  95738 20590  3750     2
  2011 187936 208917  85930 12222  6482     2
  2012  81045 163509  63423  8199  5134   738
  2013 110451 259569 141983 12758  4625   474
  2014  11721 420581  96360 35405  2974  4248
```

5.2.7.7.3 Results

The STECF EWG 15-12 applied the Extended Survivors Analysis (XSA, Shepherd, 1992) and the technique “shrinkage to the mean” for assessing the stock of whiting in 1994-2014.

Multiple XSA runs were done using different shrinkage options (Sh0.5, Sh1.0, Sh1.5, Sh2.0). Catchability was set dependent on stock size for ages >1 (rage=1) and independent of age for ages >3 (qage=3). As showed on figures 5.2.7.7.3.1-3, the different settings produced similar estimates of recruitment and SSB.

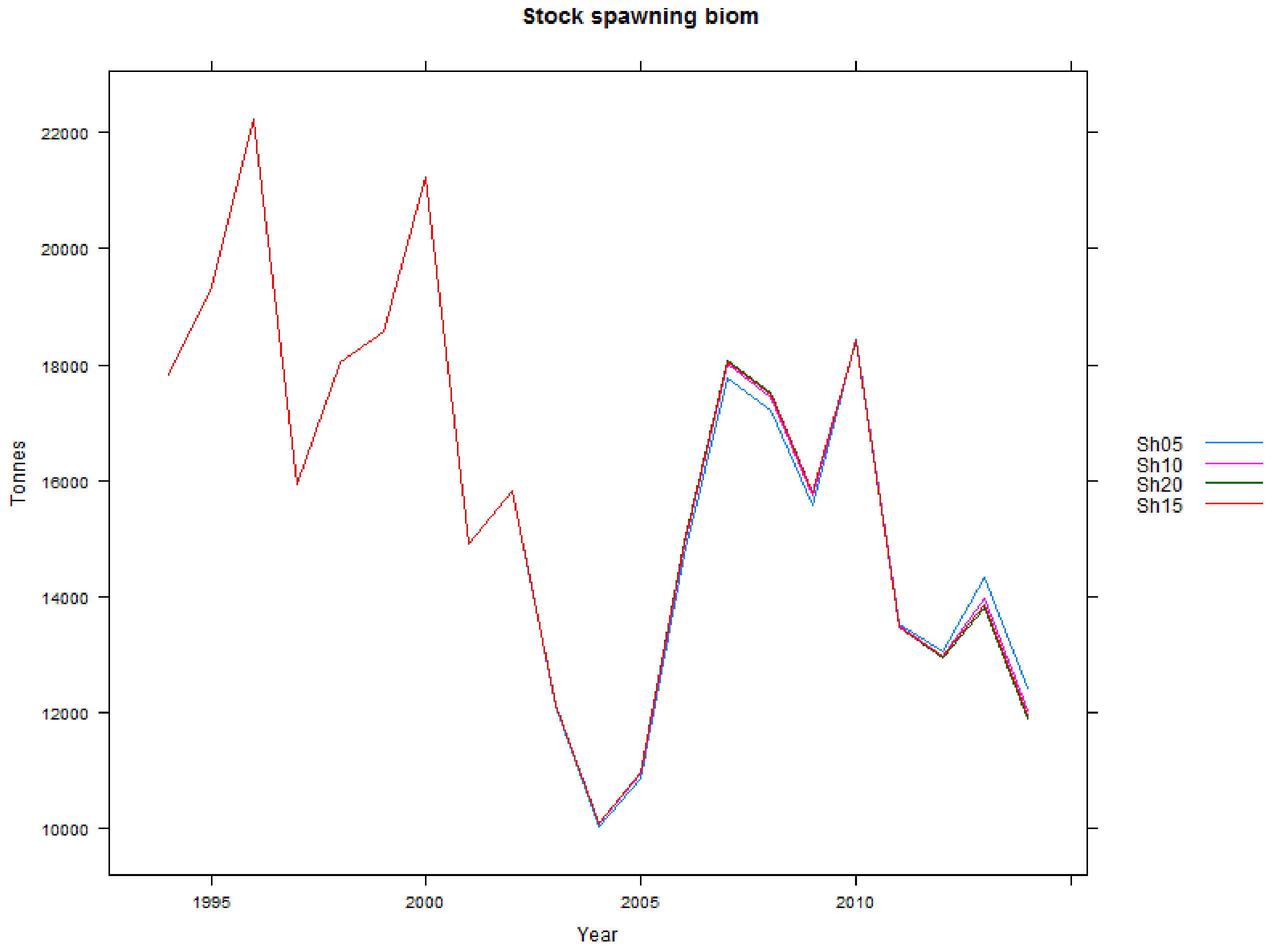


Fig. 5.2.7.7.3.1. Whiting in GSA 29. Sensitivity analysis on spawning stock biomass for different levels of shrinkage.

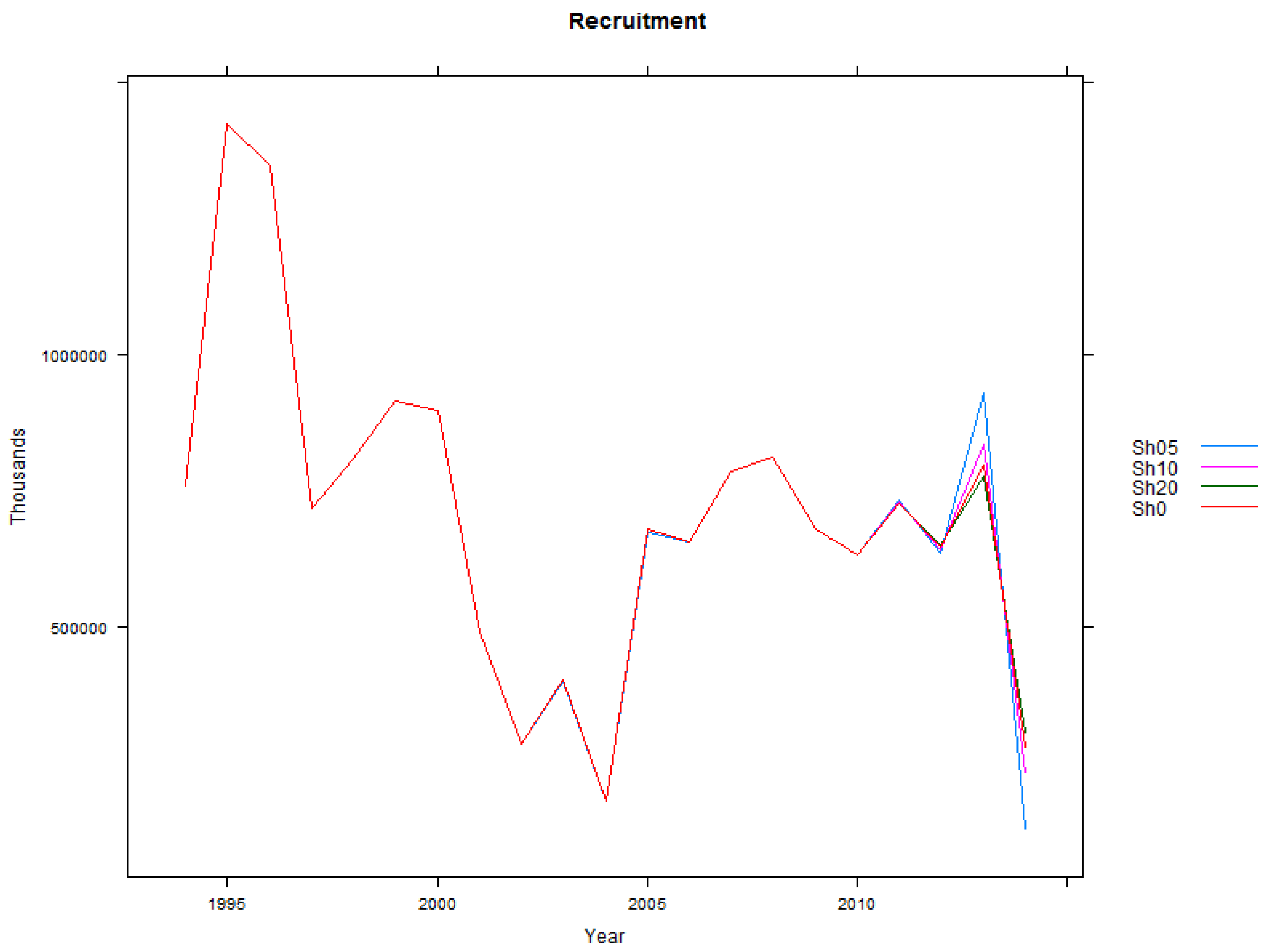


Fig. 5.2.7.7.3.2. Whiting in GSA 29. Sensitivity analysis on recruitment (age 1) for different levels of shrinkage.

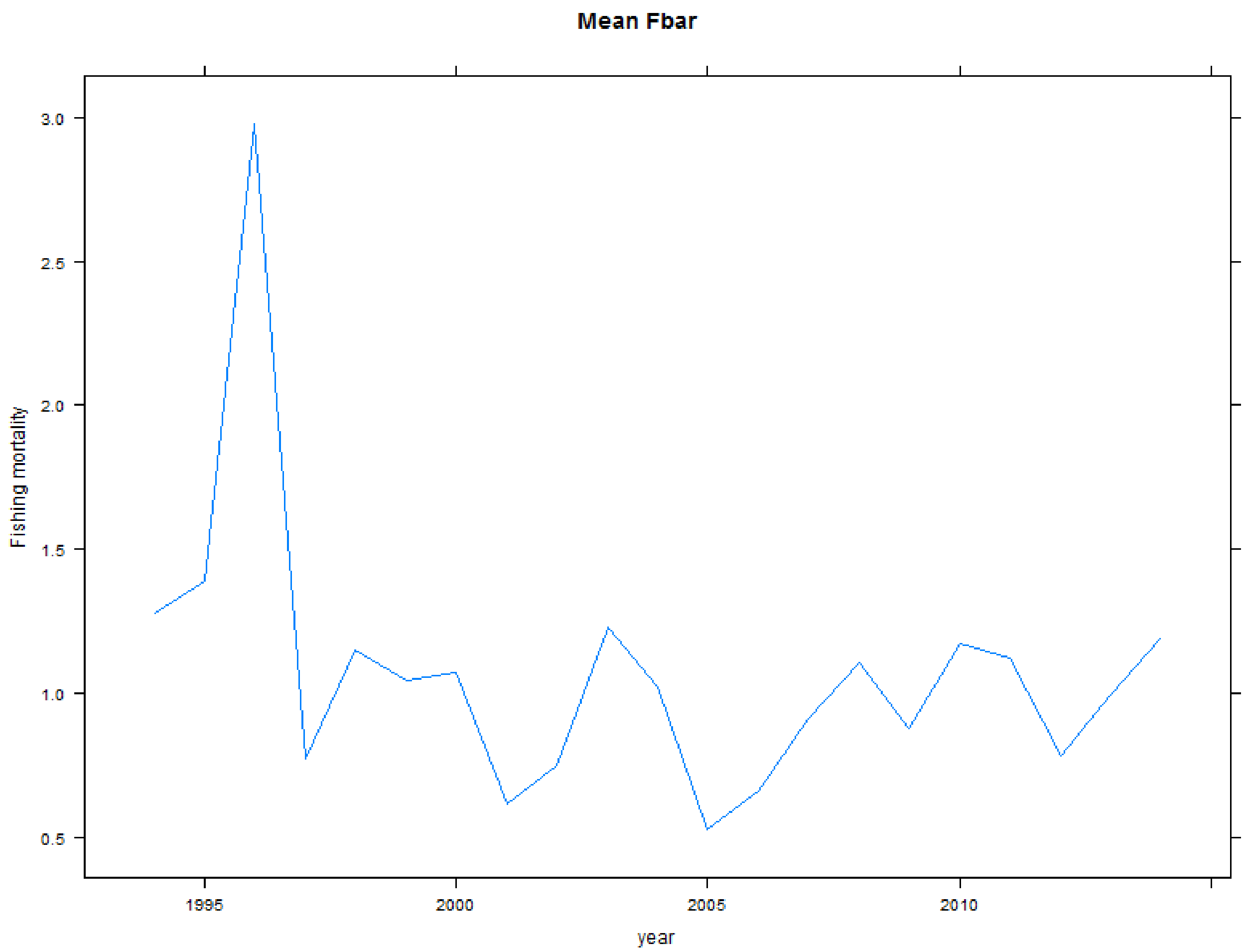
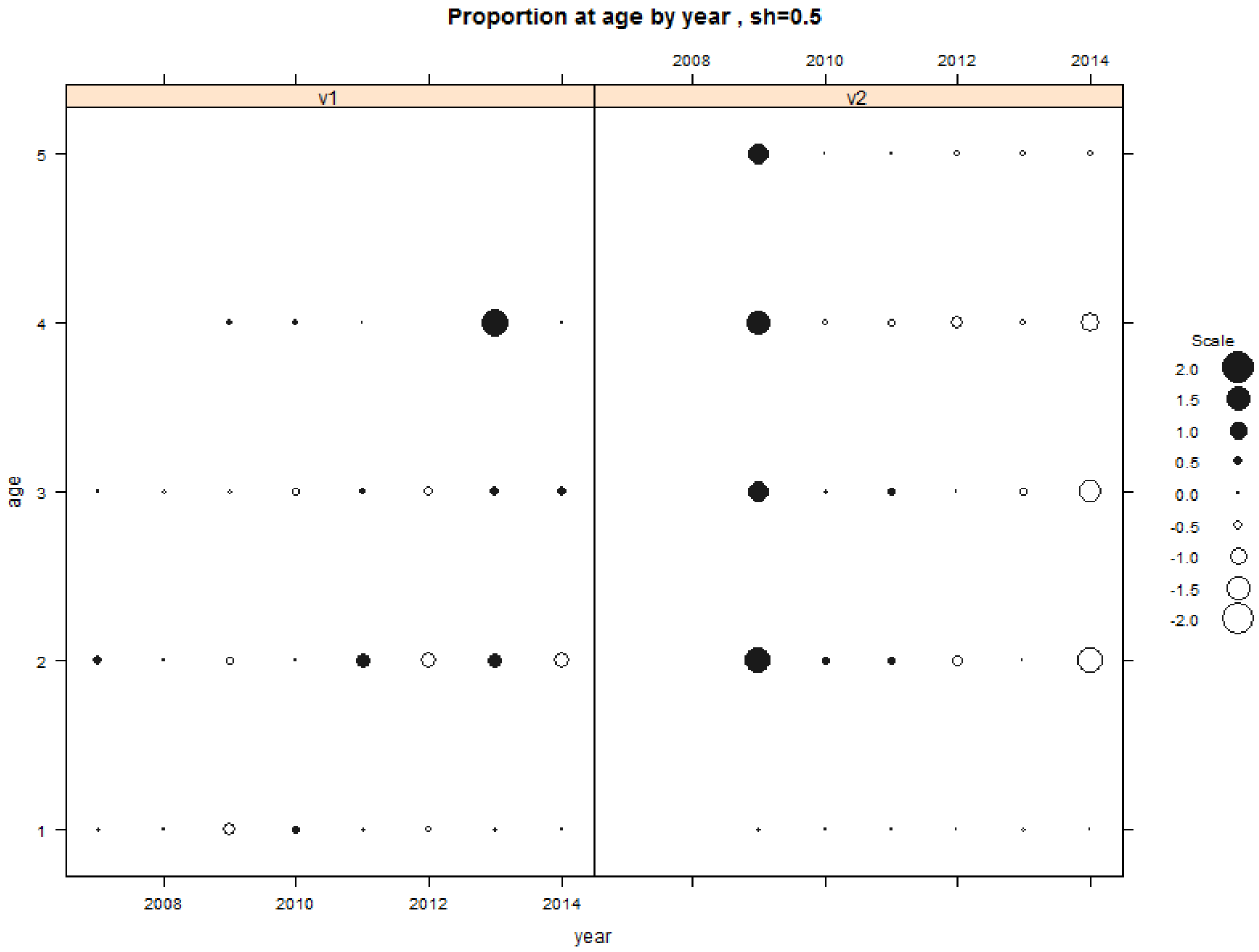
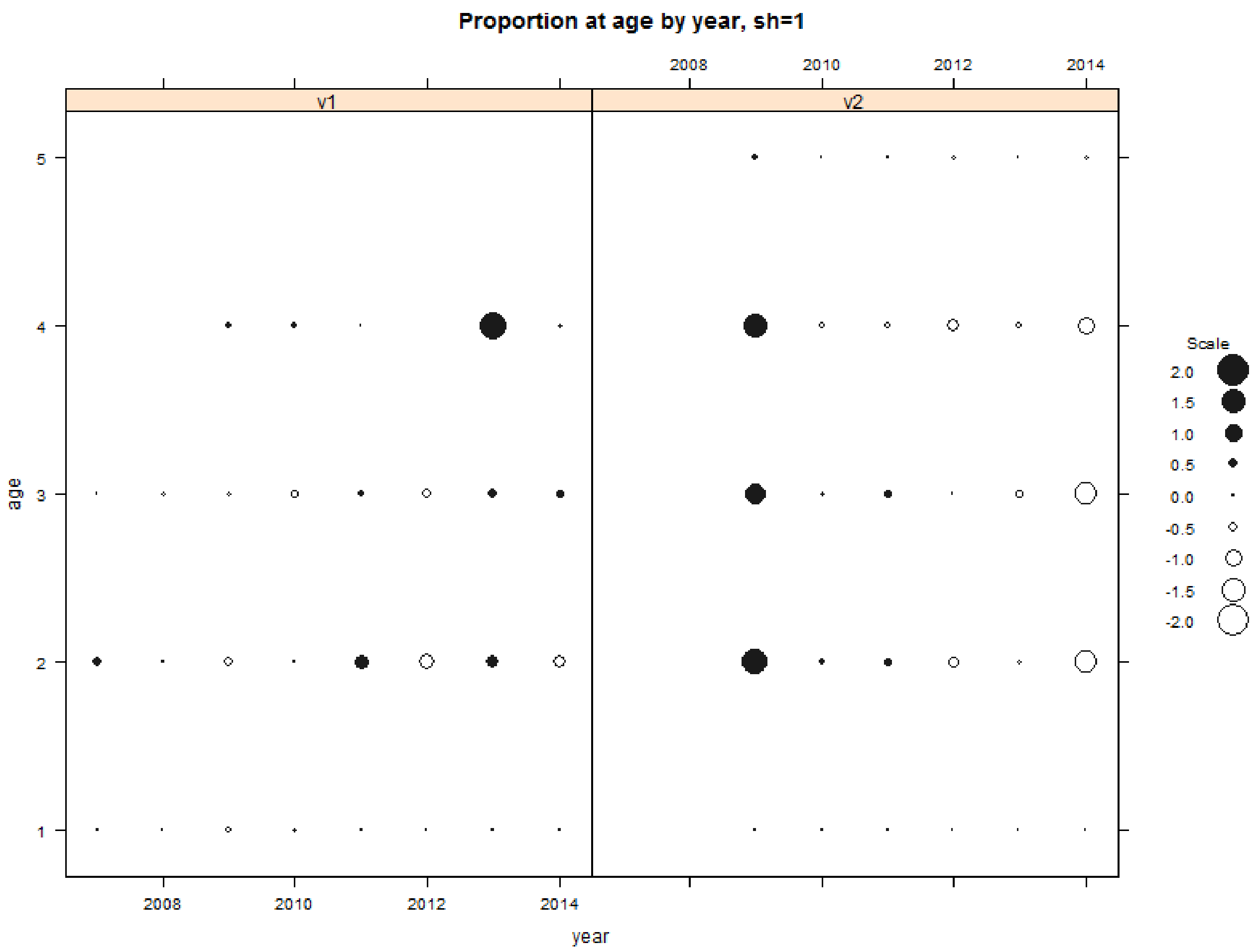
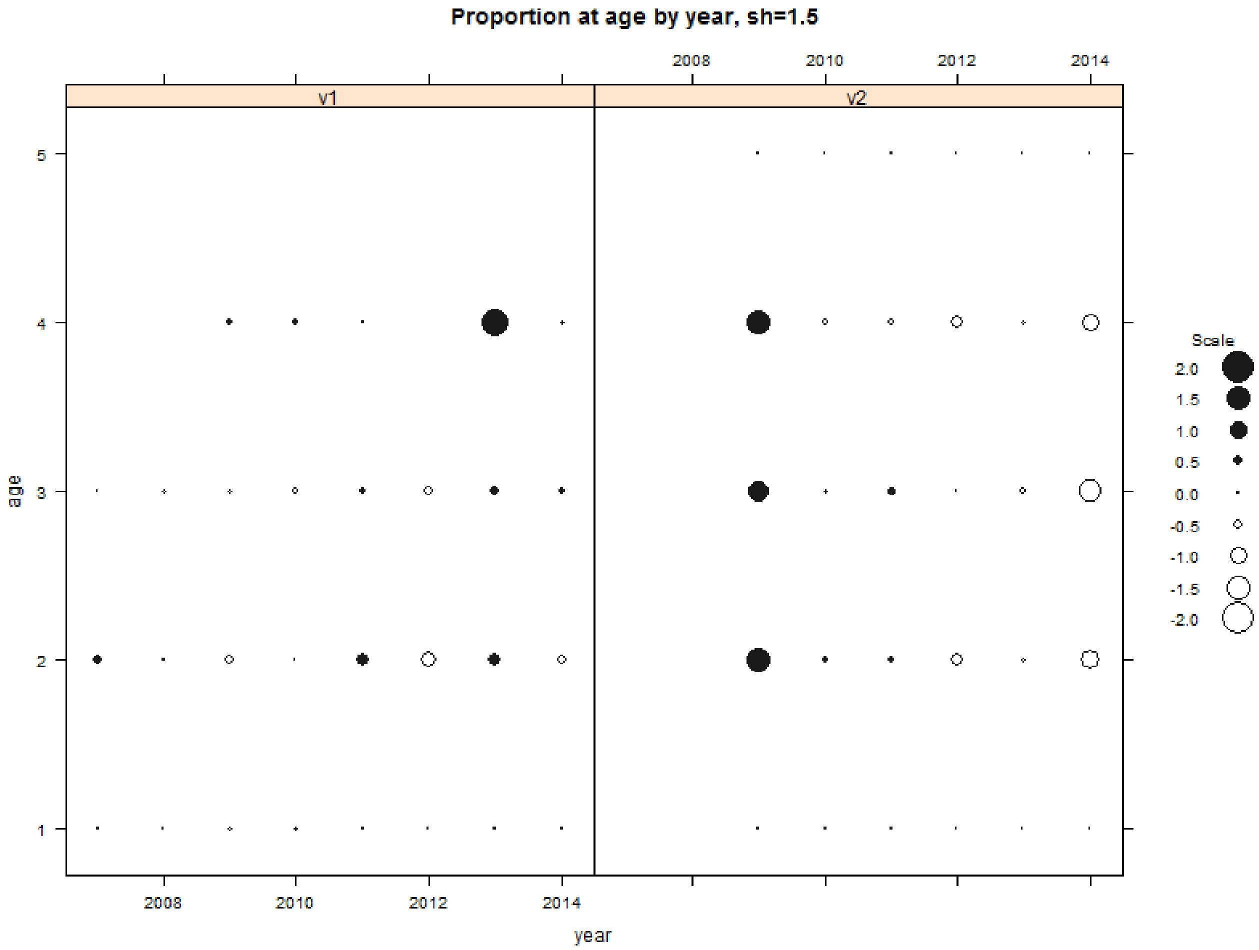


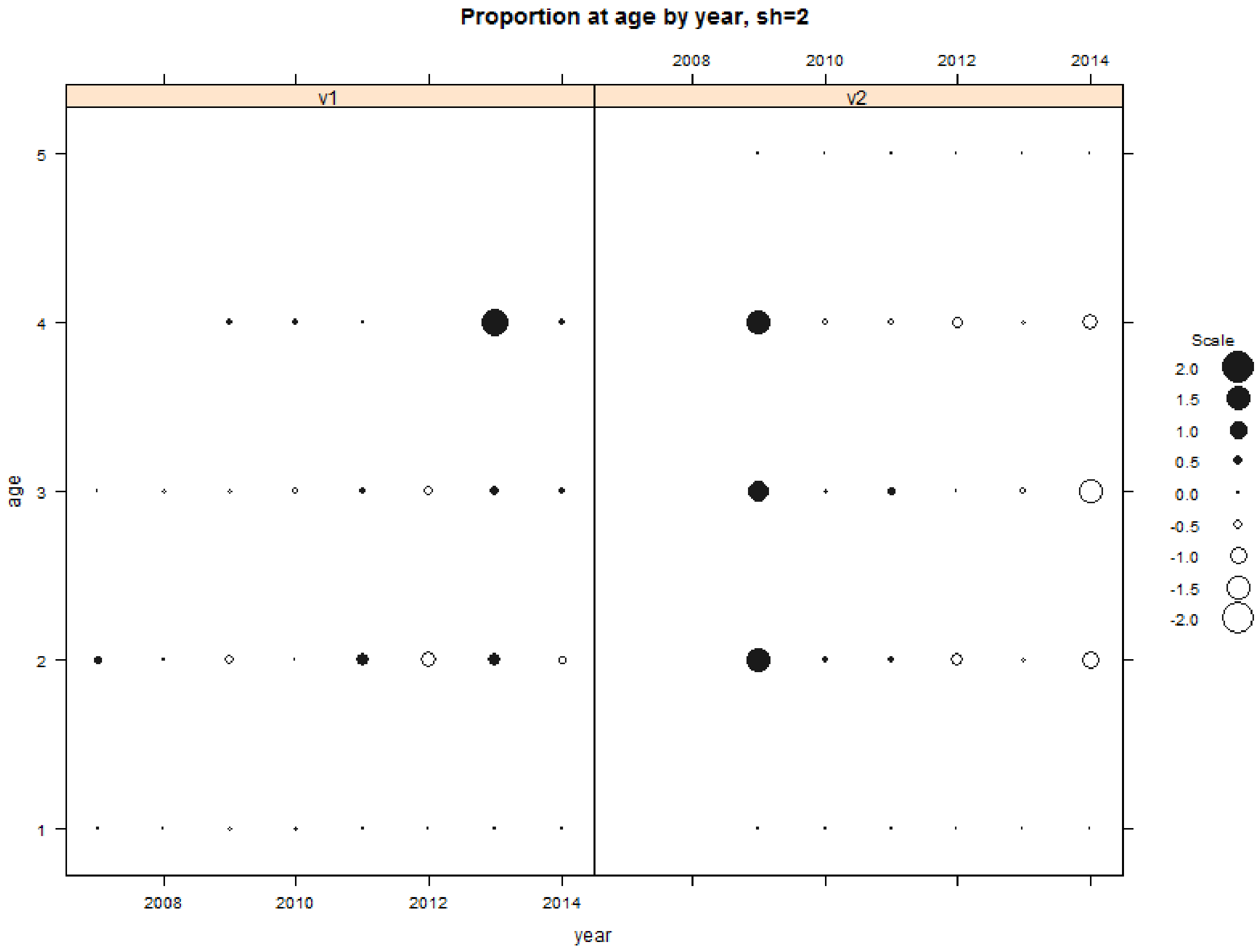
Fig. 5.2.7.7.3.3. Whiting in GSA 29. Sensitivity analysis on Fbar (1-4) for different levels of shrinkage.

The best model fit was chosen in order to downweight trends in catchability residuals for the recruiting year class caused by very high tuning indices in the survey. The residuals of log transformed catchability are plotted for each tuning index and shrinkage level in figures 5.2.7.7.3.4a-d. The bubbles plots do not indicate patterns unless the high negative values for the Turkish tuning fleet in 2009. However, the tentative to exclude the single vector (2009) from the analysis do not change or improve the assessment, or indicate a quite good agreement between years in the assessment results, with no systematic bias (Fig. 5.2.7.7.3.5).


Proportion at age by year , sh=0.5
v1
v2
age
year
Scale
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0

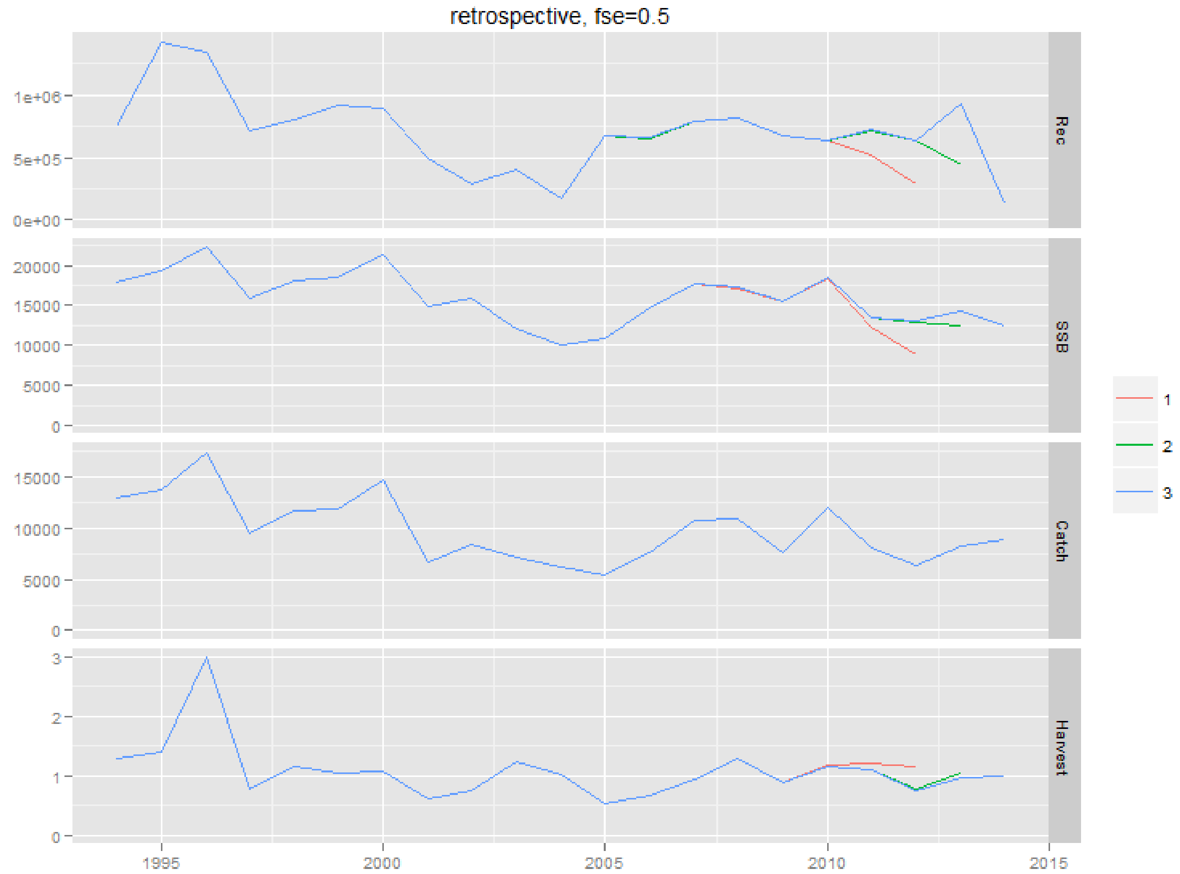

Proportion at age by year, sh=1
v1
v2
age
year
2008
2010
2012
2014
5
4
3
2
1
Scale
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0

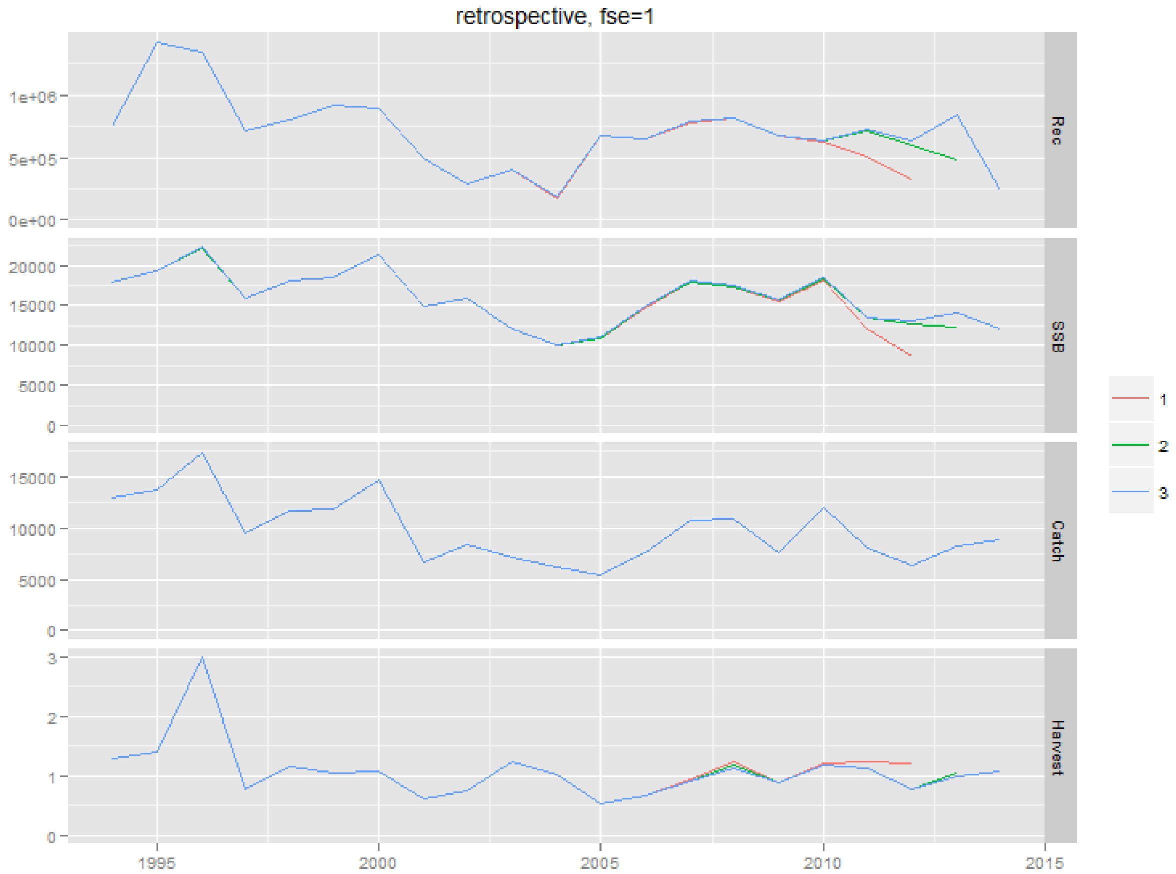

Proportion at age by year, sh=1.5
v1
v2
age
year
2008
2010
2012
2014
1
2
3
4
5
Scale
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0



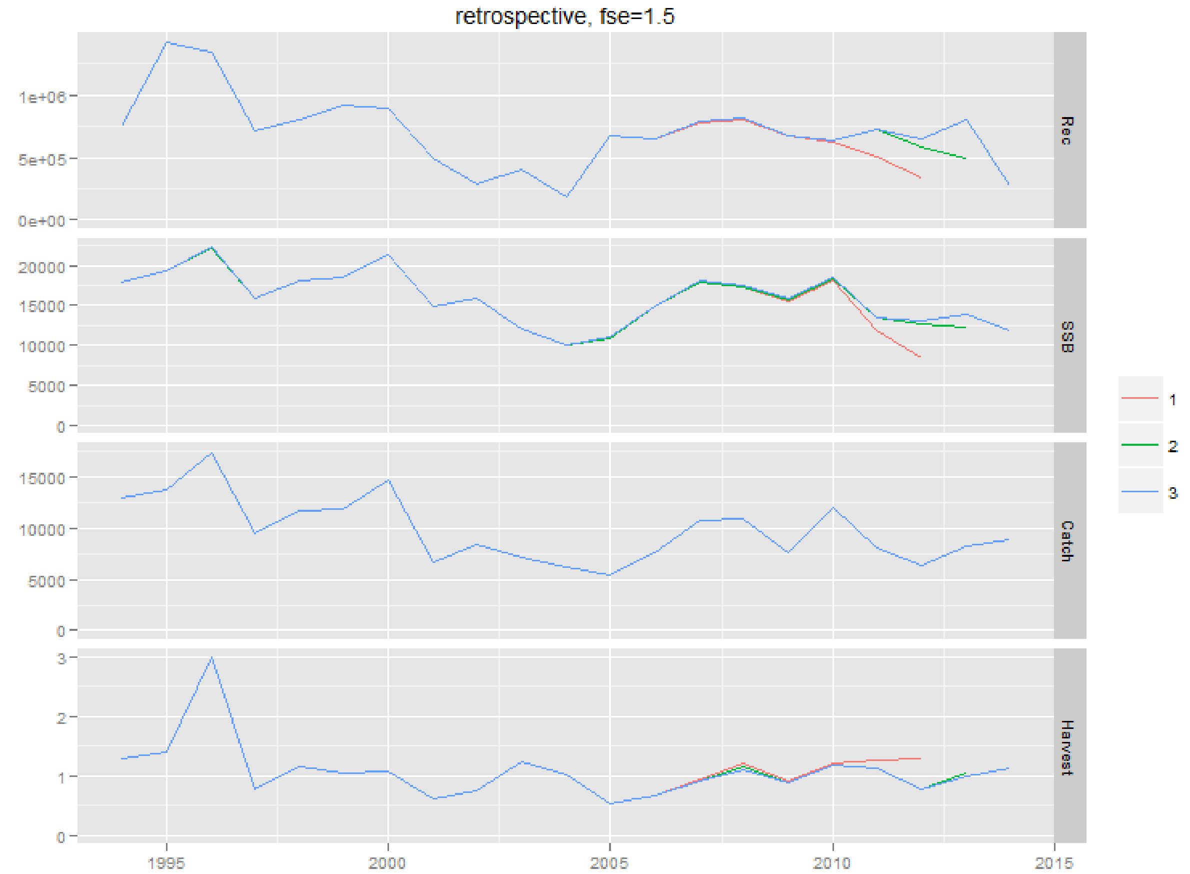
5.2.7.7.3.4. Whiting in GSA 29. Residuals of log transformed catchability applying different shrinkage values (a=0.5,b=1,c=1.5,d=2). V1=Romanian tuning index, V2=Turkish tuning index.

To ensure the robustness of the final estimates the retrospective behaviour of the fishing mortality (average over ages 1-4), SSB and recruitment for different assessment runs was analysed. The retrospective series indicate a quite good agreement between years in the assessment results, with no large systematic bias (Fig. 5.2.7.7.3.5).


retrospective, fse=0.5
1e+06
5e+05
0e+00
Rec
20000
15000
10000
5000
0
SSB
15000
10000
5000
0
Catch
3
2
1
0
Harvest
1995
2000
2005
2010
2015
1
2
3



retrospective, fse=1
1e+06
5e+05
0e+00
Rec
20000
15000
10000
5000
0
SSB
15000
10000
5000
0
Catch
3
2
1
0
Harvest
1995
2000
2005
2010
2015
1
2
3


retrospective, fse=1.5
Rec
SSB
Catch
Harvest
1e+06
5e+05
0e+00
20000
15000
10000
5000
0
15000
10000
5000
0
3
2
1
0
1995
2000
2005
2010
2015
1
2
3

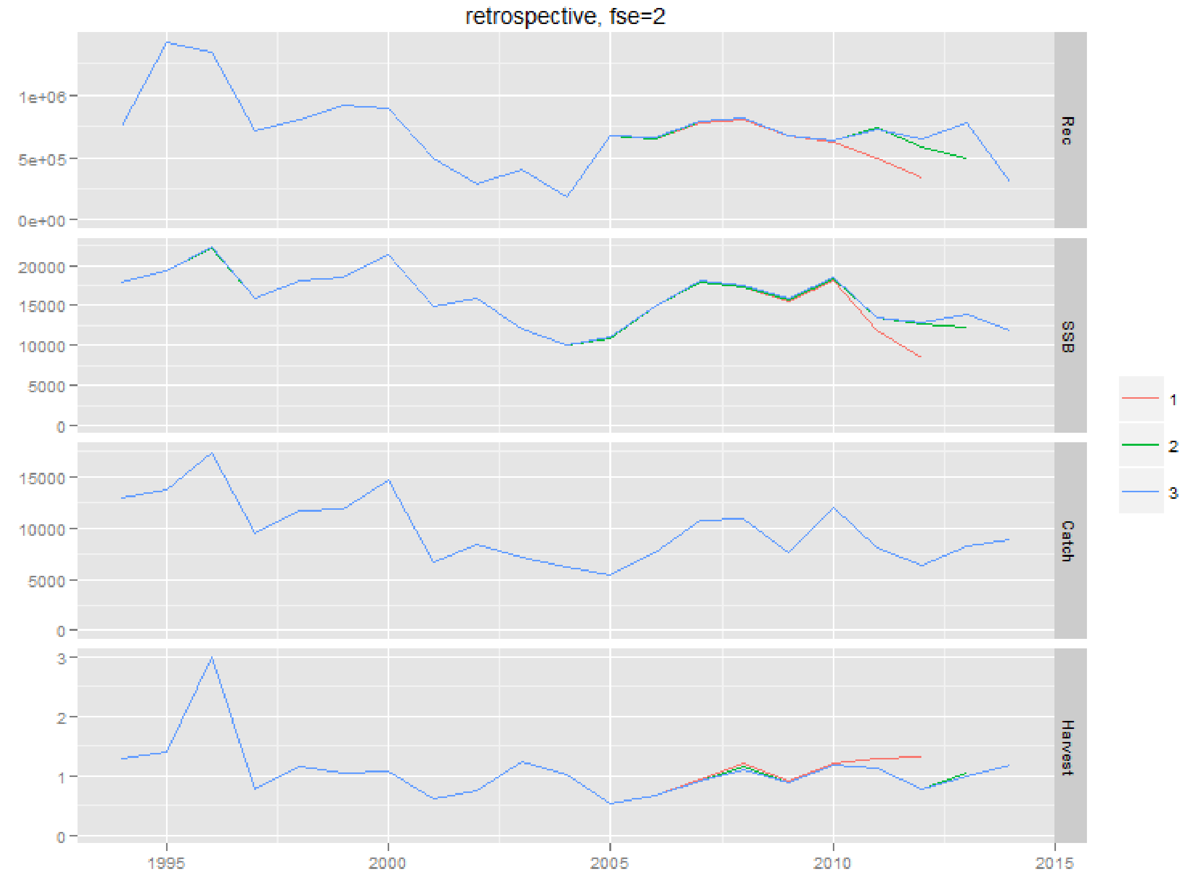


Fig. 5.2.7.7.3.5. Whiting in GSA 29. XSA retrospective patterns for last 3 years with different shrinkage sets (a=0.5,b=1,c=1.5,d=2).

Overall the best model in terms of residual plots and retrospective patters is the model with shrinkage of 1 and this basis this XSA run is the retained one (Fig. 5.2.7.7.3.6).

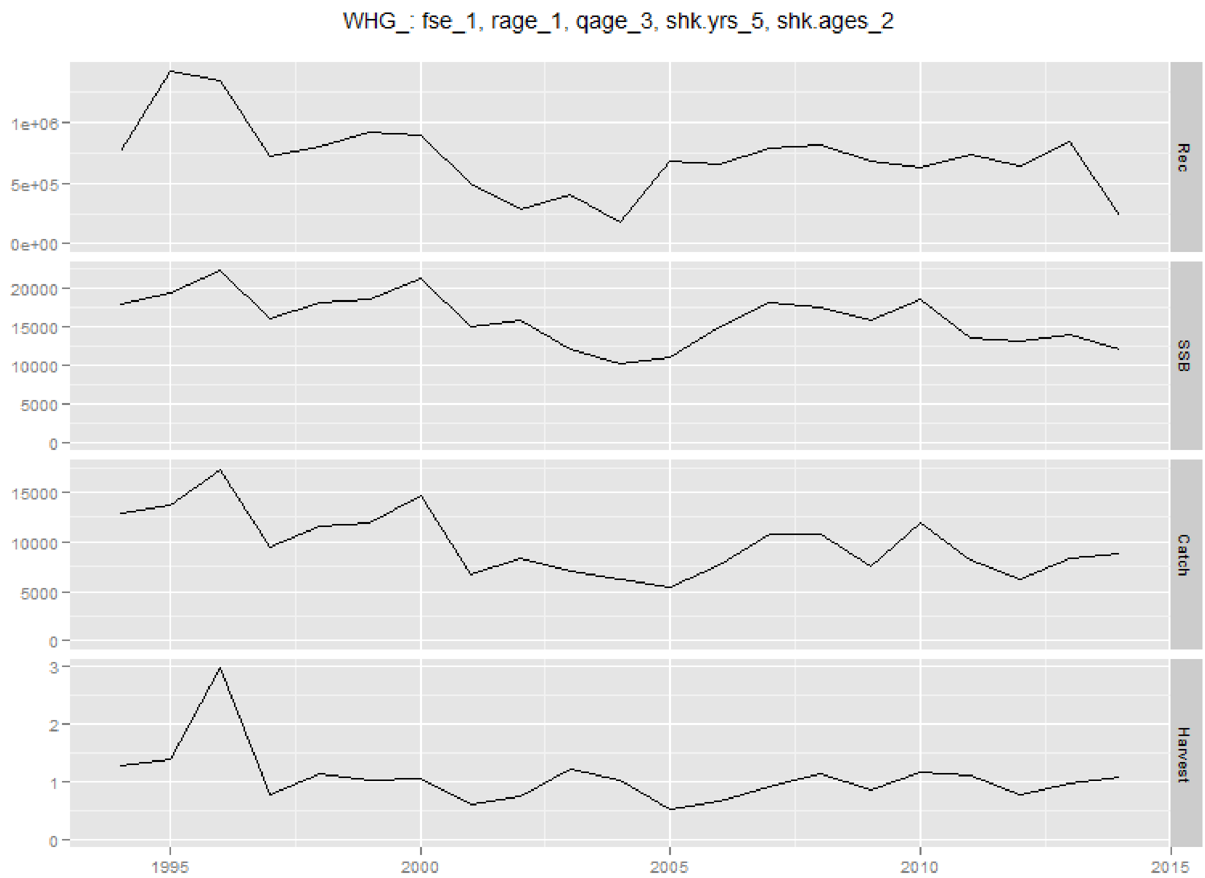


Fig. 5.2.7.7.3.6. Whiting in GSA 29. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

XSA outputs and diagnostics are listed below respectively in tables 5.2.7.7.3.1 and 5.2.7.7.3.2.

Table 5.2.7.7.3.1. Whiting in GSA 29. XSA results.

year	ssb	fbar	rec	catch	landings
1994	17812	1.28	758925	12898	12898
1995	19336	1.39	1423524	13717	13717
1996	22221	2.97	1349332	17350	17350
1997	15946	0.77	718428	9489	9489
1998	18033	1.15	809556	11657	11657
1999	18577	1.04	916595	11862	11862
2000	21235	1.07	897241	14636	14636
2001	14920	0.62	492686	6711	6711
2002	15838	0.75	287627	8426	8426
2003	12133	1.23	403748	7075	7075
2004	10092	1.02	180645	6261	6261
2005	10961	0.53	679887	5421	5421
2006	14892	0.66	656813	7632	7632
2007	18004	0.92	786886	10805	10805

2008	17440	1.13	812769	10833	10833
2009	15751	0.88	680827	7546	7546
2010	18413	1.17	634454	11967	11967
2011	13493	1.12	730474	8147	8147
2012	12979	0.78	640885	6320	6320
2013	13979	0.99	837398	8308	8308
2014	12024	1.08	232209	8861	8861

Table 5.2.7.7.3.2. Whiting in GSA 29. XSA diagnostic.

```
                                EWG1512_WHG_diagnostic.log
FLR XSA Diagnostics 2015-10-02 07:15:57

CPUE data from indices

Catch data for 21 years 1994 to 2014. Ages 1 to 6.

                                                           fleet first age last age first
year last year
1                                                 RO Trawl fleet         1        4
2007      2014
2 TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)         1        5
2009      2014
  alpha beta
1  <NA> <NA>
2  <NA> <NA>


 Time series weights :

    Tapered time weighting applied
   Power =   3 over  20 years

 Catchability analysis :

     Catchability independent of size for ages >   1

     Catchability independent of age for ages >   3

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  2 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   1

    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age    2005 2006  2007  2008  2009  2010 2011  2012 2013 2014
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
   year
age  2005  2006  2007  2008  2009  2010  2011  2012  2013  2014
  1 0.763 0.650 0.683 0.617 0.189 0.441 0.346 0.155 0.162 0.059
  2 0.287 1.094 1.390 1.059 0.922 1.311 1.208 0.568 1.044 1.656
  3 0.768 0.500 0.739 1.044 1.073 1.741 1.901 1.522 1.304 1.384
  4 0.301 0.408 0.853 1.818 1.321 1.188 1.012 0.857 1.443 1.235
  5 0.535 0.454 0.797 1.434 0.398 1.487 1.374 1.448 1.591 1.533
  6 0.535 0.454 0.797 1.434 0.398 1.487 1.374 1.448 1.591 1.533


 XSA population number (Thousand)
      age
year        1      2      3     4     5    6
```

```
  2005 679887  69375  74190 23979  3736  638
  2006 656813 245457  46362 32090 16936  842
  2007 786886 265459  73152 26236 20365 5488
  2008 812769 307689  58869 32576 10674 1040
  2009 680827 339403  95007 19333  5046    6
  2010 634454 436089 120207 30314  4925    2
  2011 730474 315788 104603 19654  8821    3
  2012 640885 399990  84001 14574  6822  977
  2013 837398 424690 201802 17095  5902  603
  2014 232209 550904 133157 51095  3855 5484


 Estimated population abundance at 1st Jan  2015
      age
year      1      2     3     4     5   6
  2015 28105 169411 93597 31133 14186 806


 Fleet:  RO Trawl fleet

 Log catchability residuals.

   year
age   2007   2008   2009   2010   2011   2012  2013   2014
  1  0.035 -0.006 -0.267  0.180  0.081 -0.105 0.063  0.015
  2  0.464  0.055 -0.441  0.006  0.775 -0.893 0.741 -0.660
  3 -0.026 -0.146 -0.152 -0.322  0.235 -0.496 0.505  0.374
  4     NA     NA  0.265  0.243 -0.009     NA 1.600  0.155

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.608617181851687" "4.97481937505609"


 Fleet:  TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)

 Log catchability residuals.

   year
age  2009   2010   2011   2012   2013   2014
  1 0.062  0.038  0.008 -0.020 -0.070 -0.014
  2 1.499  0.289  0.333 -0.637 -0.119 -1.288
  3 1.215  0.160  0.400 -0.057 -0.325 -1.329
  4 1.437 -0.258 -0.291 -0.666 -0.214 -1.060
  5 0.220 -0.049  0.036 -0.112 -0.105 -0.148

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.225381231136021" "11.7980245156565"


 Terminal year survivor and F summaries:

 ,Age 1 Year class =2013

source
                                                              scaledWts survivors yrcls
RO Trawl fleet                                                    0.403    173608  2013
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)     0.395    159082  2013
fshk                                                              0.043     34619  2013
```

```
nshk                                                           0.159    285865  2013

 ,Age 2 Year class =2012

source
                                                           scaledWts survivors yrcls
RO Trawl fleet                                                 0.259     48397  2012
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)  0.114     25827  2012
fshk                                                           0.627    224860  2012

 ,Age 3 Year class =2011

source
                                                           scaledWts survivors yrcls
RO Trawl fleet                                                 0.577     45248  2011
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)  0.099      8238  2011
fshk                                                           0.324     26219  2011

 ,Age 4 Year class =2010

source
                                                           scaledWts survivors yrcls
RO Trawl fleet                                                 0.209     16558  2010
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)  0.195      4917  2010
fshk                                                           0.596     15627  2010

 ,Age 5 Year class =2009

source
                                                           scaledWts survivors yrcls
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)  0.706       695  2009
fshk                                                           0.294      1078  2009
```

5.2.7.8 Reference points

5.2.7.8.1 Methods

Since whiting is mainly a pelagic species the Patterson Exploitation E=0.4 was selected as reference point consistent with long term exploitation of the stock.

5.2.7.9 Data quality

The main data deficiency that conditions the EWG15-12 assessment of whiting is related to the data fleet used for tuning. To improve the assessment of both trends in total mortality and recruitment EWG15-12 underline the need of international hydro-acoustic/bottom trawl survey to derive trends of biomass indices and of age-structure of the across all the riparian countries of the Black Sea. Further a calibration of the age reading of whiting is needed to avoid discrepancy among national catch-at-age data. The poor information of discarding rates for most of the countries for the Black Sea do not allow to full evaluate the stock (particularly for those related to 0 ages).

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of discards for the age 0 and 1 and to the absence of an internationally coordinated bottom trawl survey.

5.2.7.10 Short term predictions 2015-2017

5.2.7.10.1 Method

No short term forecast was performed as the assessment is only indicative of trends.

5.2.7.11 Medium term predictions

Not conducted.

5.2.7.12 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed E_{MSY} level (0.40), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of whiting in GSA 29 in 2016 consistent with E_{MSY} cannot be estimated as the assessment is only indicative of trends.

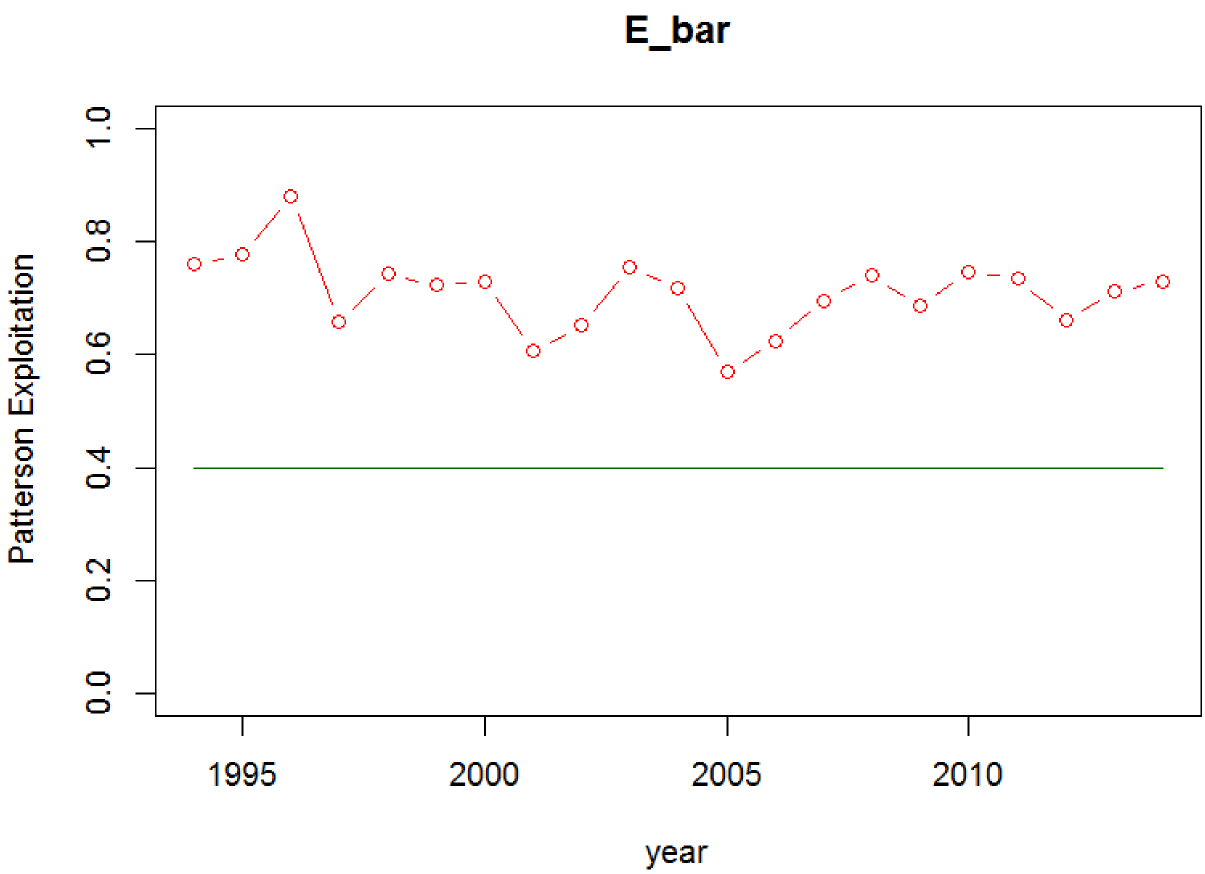


Fig. 5.2.7.12.1. Whiting in GSA 29. Exploitation rate in relation to the reference point (E=0.4).

5.2.8 STOCK ASSESSMENT OF THORNBACK RAY

5.2.8.1 Stock Identification

Thornback ray, *Raja clavata*, is widely distributed in coastal waters of the eastern Atlantic, ranging from Norway and Iceland to Northwest Africa, including the Skagerrak, Kattegat and western Baltic Sea, Mediterranean and Black Seas (Stehmann and Bürkel, 1986; Stehmann, 1995). Thornback ray is a bottom-dwelling species on the shelf and upper slope from inshore to depths of 300 m (Stehmann and Bürkel, 1984), while mainly distributed from 10 to 70 m in the Black Sea (Aydin et al., 2009). The main factor affecting the distribution of this species is temperature (Jardas, 1973).

5.2.8.2 Growth

Length, width and weight ranges are given in Table 5.2.8.2.1 (Turkish data). Age is ranging between 1 and 12 years. The growth parameters were estimated from age reading using vertebrae. VBGF and L-W relationship parameters are shown in Table 5.2.8.2.2.

Table 5.2.8.2.1. Thornback ray in GSA 29. Mean, minimum, and maximum length, width, and weight.

Years	Length (cm)			Width (cm)			Weight (g)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
2009	67.23±1.27	14.1	93	45.71±0.90	8.7	64.5	2500±89	14.8	5399
2010	58.84±1.75	14.3	88.4	40.21±1.24	9.4	64.5	1859±129	14.9	5004
2011	55.33±1.43	14.9	89	37.33±0.99	9.2	61	1487±94	14	4800
2013	51.94±1.35	16.5	92	35.54±0.96	10.2	62.5	1304±94	25	5150
2014	59.26±1.07	16.8	92	40.85±0.74	9.5	63.5	1865±87	25.5	5265

Table 5.2.8.2.2. Thornback ray in GSA 29. Parameters of VBGF and L-W relationship.

Parameters	Years				
	2009	2010	2011	2013	2014
a	0.0035	0.0025	0.0023	0.0029	0.0031
b	3.1421	3.2300	3.2356	3.1982	3.1864
L_∞ (cm)	119.12	119.31	128.93	124.26	121.39
W_∞ (g)	11669.77	12752.90	15487.78	13746.26	13565.5
k (cm/year)	0.119	0.113	0.100	0.107	0.112
t_o (year)	-0.467	-0.436	-0.920	-0.511	-0.518
Φ	3.233	3.208	3.220	3.188	3.219

5.2.8.3 Maturity

Thornback ray are oviparous and enclose their internally fertilized eggs within a tough case before laying them on shallow bottoms. Most of its embryonic development occurs after oviposition and may take up to 15 months (Berestovskii 1994; Conrath 2004; Musick and Ellis 2005). Stehmann and Bürkel, (1984) reported that more than 170 egg cases can be laid by a single female in a year, although average fecundity is much lower (around 48-74 eggs) (Ryland and Ajayi, 1984). For Black Sea, it was reported from 27 to 60 by Saglam and Ak (2011). In the Black Sea, oviposition takes place from July to October (Saglam and Ak, 2011). Size at first maturity of males and females is 720 mm and 745 mm, respectively (Saglam and Ak, 2011).

5.2.8.4 Natural mortality

Natural mortality was estimated in 2014 as 0.144 using Pauly's equation. Estimation from previous years are given in Table 5.2.8.4.1.

Table 5.2.8.4.1. Thornback ray in GSA 29. Natural mortality.

Parameter	Years				
	2009	2010	2011	2013	2014
M	0.150	0.145	0.131	0.138	0.144

5.2.8.5 Fisheries

5.2.8.5.1 General description of the fisheries

Thornback ray is one of the most abundant elasmobranch species landed by the Black Sea fisheries as bycatch. Commercially, thornback ray is of marginal importance. They appear as a bycatch in Turkey, Ukraine, Russia and Romania fisheries. Gönener and Bilgin (2009) reported that thornback ray was caught as by-catch in turbot gill net fisheries.

5.2.8.5.2 Management regulations applicable in 2015

There are no management regulations for Thornback ray. Commercial Fishery Advice of General Directorate of Fishery in Turkey banned bottom trawling in the following areas in the period 2012-2014: Sinop-İnceburun and Samsun-Çayağzı cape, Ordu-Ünye-Taşkana cape and Georgia border. Furthermore, trawling is banned within 2 miles from land between Zonguldak-Ereğli-Baba cape and Bartın-Amasra-Tekke cape. In the rest of Turkish waters, trawling cannot take place within 3 miles from the coast. Bottom trawling fisheries are banned between 15 April and 15 September. Turbot fishery by gillnet is allowed except during the period 15 April-15 June. As concerns purse seine, fishing is not allowed in waters shallower than 24 m. The depth of purse seine net cannot be more than 164 m. Fishing period of purse seine is between 1 September and 15 April. There is no minimum landing size for R. clavata in the Black Sea.

5.2.8.5.3 Catches

Thornback ray is a non-target species in the Black Sea fisheries. It is reported as bycatch in several demersal fisheries.

5.2.8.5.4 Landings

Thornback rays are caught as a by-catch by demersal trawl, purse seine, long line and gillnet fisheries in the Black Sea. The largest catches were observed in the early 1980s (Table 5.2.8.5.4.1). In the 1990s, landings of Thornback ray decreased by approximately 50% every year. This sharp decrease may be due to the fact that Thornback ray have low fecundity, slow growth, and late maturity, hence they are potentially vulnerable to exploitation (Brander, 1981; Heist, 1999). In 2014, total landings in Bulgaria, Romania and Turkey were 96.5 tons (Table 5.2.8.5.4.1).

Table 5.2.8.5.4.1. Thornback ray in GSA 29. Landings by country.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1967	-	-	-	-	1683	-	1683
1968	-	-	-	-	1721	-	1721

1969	-	-	-	-	1513	-	1513
1970	-	-	-	-	836	-	836
1971	-	-	-	-	2149	-	2149
1972	-	-	-	-	1193	-	1193
1973	-	-	-	-	290	-	290
1974	-	-	-	-	238	-	238
1975	-	-		Former URSS	52	52	51.7
1976	-	-	-	1200	119	-	1319
1977	-	-	-	1000	256	-	1256
1978	-	-	-	1200	998	-	2198
1979	-	-	-	1100	3390	-	4490
1980	-	-	-	1100	2069	-	3169
1981	-	-	-	1000	1147	-	2147
1982	-	-	-	1400	1554	-	2954
1983	-	-	-	1000	3078	-	4078
1984	-	-	-	1200	904	-	2104
1985	-	-	-	1100	1087	-	2187
1986	-	-	-	900	797	-	1697
1987	-	-	-	400	880	-	1280
1988	-	-	-	400	974	-	1374
1989	-	-	-	700	1254	-	1954
1990	-	-	-	400	633	-	1033
1991	-	-	-	300	778	-	1078
1992	-	-	-	100	1155	-	1255
1993	-	-	-	-	636	-	636
1994	-	-	-	-	687	-	687
1995	-	-	-	-	185	-	185
1996	-	-	-	-	267	-	267
1997	-	-	-	-	490	-	490
1998	-	-	-	-	855	-	855
1999	-	-	-	-	185	-	185
2000	-	-	-	-	951	-	951
2001	-	-	-	-	422	-	422
2002	-	-	-	-	175	-	175
2003	-	-	-	-	257	-	257
2004	-	-	-	-	253	-	253
2005	-	-	-	-	249	-	249
2006	-	-	-	-	365	-	365
2007	-	-	-	-	237	-	237
2008	-	-	-	-	117	-	117
2009	49	-	-	-	264	-	313
2010	72	-	-	-	102	-	174
2011	7	-	-	-	81	-	88
2012	48	-	-	-	94	-	142

2013	56	-	-	-	77	-	133
2014	70	-	0.2	-	26	-	97

5.2.8.5.5 Discards

No data were presented at EWG 15-12.

5.2.8.5.6 Fishing effort

No data were presented at EWG 15-12.

5.2.8.6 Scientific surveys

5.2.8.6.1 Survey #1

R. clavata speciemens were collected under the project of "Investigation of Opportunities on Cultivation of Gurnard (*Chelidonichthys lucerna* L., 1758)" from Samsun to neighbor of Georgia border in August 2014. In previous years, some data were collected under the "Research on Bio-Ecological Properties and Aquaculture Possibilities of Flounder (*Platichthys flesus luscus* Pallas, 1811)" in the Trabzon area.

5.2.8.6.1.1 Methods

Fish were captured using a bottom trawl net (14*12 mm mesh, vertical height 12 m, horizontal opening 22.5 m) by the R/V SÜRAT Araştırma-1. Sixteen hauls were carried out in summer 2014.

5.2.8.6.1.2 Geographical distribution

The survey was performed at depths ranging from 20 to 80 m along the Turkish coasts.

5.2.8.6.1.3 Trends in abundance and biomass

The abundance (n. individuals/km^2) of Thornback ray along the Turkish coasts is presented in Figure 5.2.8.6.1.3.1.

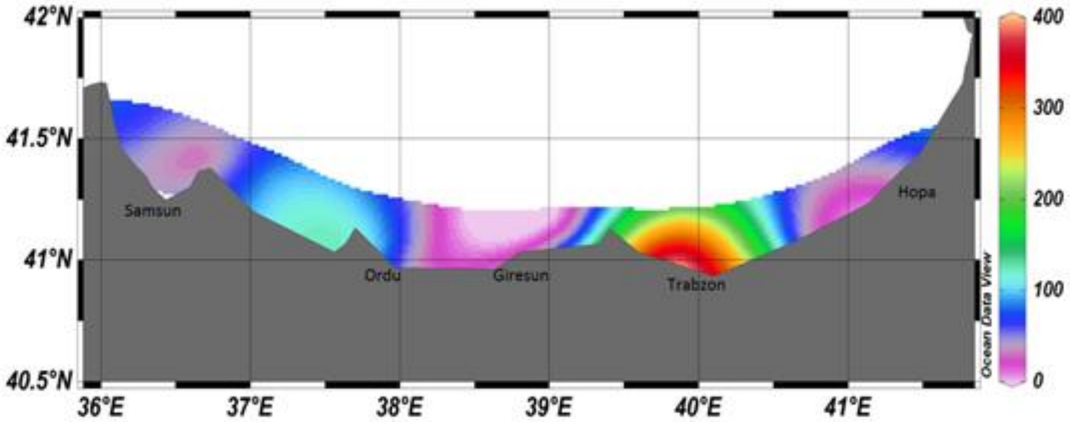


Figure 5.2.8.6.1.3.1. Thornback ray in GSA 29. The abundance of Thornback ray in the Turkish coasts in August 2014 (n. individuals/km^2).

5.2.8.6.1.4 Trends in abundance by length or age
No data on size or age distribution are available.

5.2.8.6.2 Survey #2
More recently, data on Thornback ray were collected from the Bulgarian Black Sea coast in two surveys in the period July and September 2014.

5.2.8.6.2.1 Methods
Trawling was carried out using an otter trawl net with codend mesh size of 6 mm.

5.2.8.6.2.2 Geographical distribution
The surveys were carried out in 12-mile zone off the Bulgarian coasts. Four depth strata were sampled: 10-20m; 20-30m; 30-40m; 40-50m.

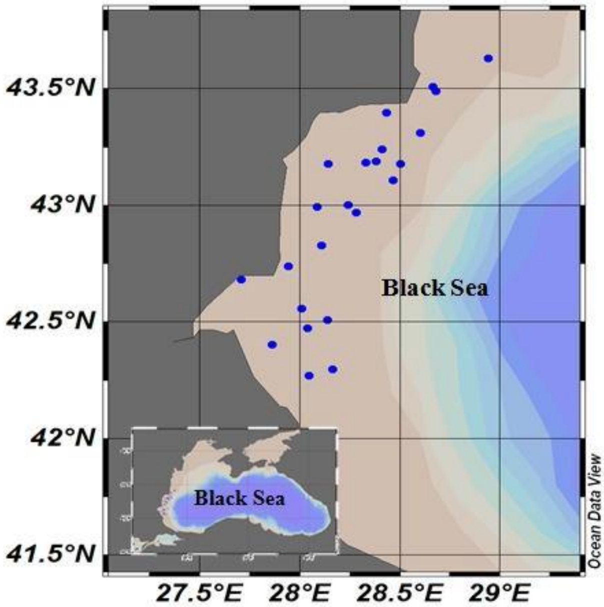


Fig. 5.2.8.6.2.2.1. Thornback ray in GSA 29. Map showing area and localities of catches off the Bulgarian coasts.

5.2.8.6.2.3 Trends in abundance and biomass
Spatial distribution of thornback ray off the Bulgarian coasts is shown in the following figure.

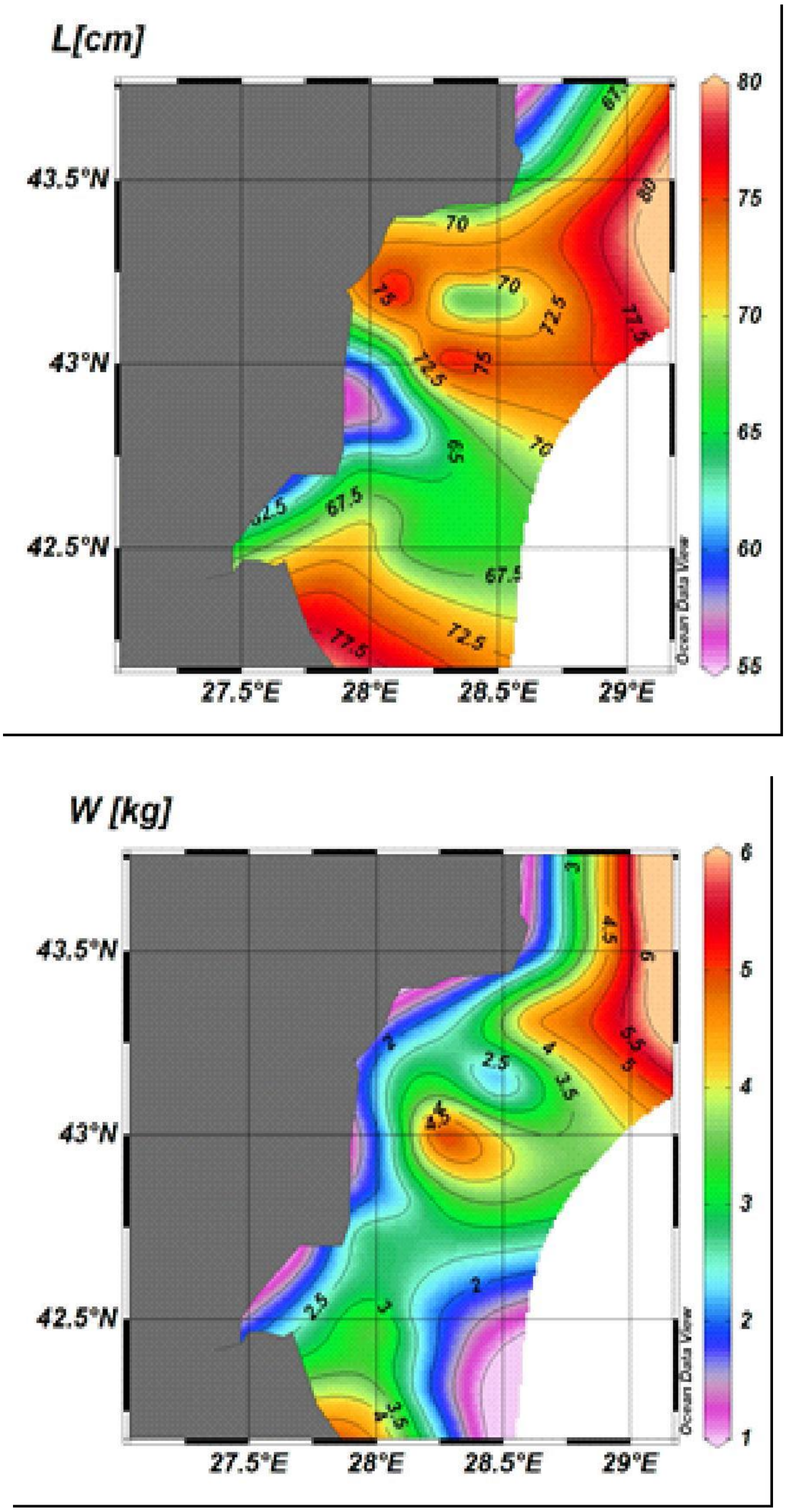


Fig. 5.2.8.6.2.3.1. Thornback ray in GSA 29. Distribution by length, cm (A), and weight, kg (B).

5.2.8.6.2.4 Trends in abundance by length or age

No information on age structure is available from the Bulgarian surveys.

5.2.8.7 Stock Assessment

5.2.8.7.1 Methods

EWG 15-12 used the pseudo-cohort analysis run by the VIT program (Lleonart and Salat, 1992) for the estimation of abundance and fishing mortality of Thornback ray in the Black Sea.

The program VIT is conceived for the analysis of fisheries where the available information is limited. VIT is designed for the analysis of marine populations, exploited by one or several gears, based on single species catch data (structured by age or size). The main assumption underlying the model is the steady state, because the program works with pseudo-cohorts and it is therefore not suitable for historical data series.

The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it by means of Virtual Population Analysis (VPA). Once the virtual population has been rebuilt, an analysis of the fishery can be carried out with the aid of several tools: Comprehensive VPA results, Yield-per-Recruit analysis based on the fishing mortality vector, analysis of sensitivity to parameter values and transition analysis. The latter permits non-equilibrium analysis of how a shift in exploitation regime is reflected in the fisheries. All these tools can be applied to specific studies of competition among fishing gears.

5.2.8.7.2 Input data

Landings from Bulgaria and Turkey for the period 2008-2014 were used. Data from Georgia, Russia, Ukraine were not available, and those from Romania were available for 2014 only. Catch numbers-at-age from Turkey were used to estimate the catch composition of Bulgarian landings.

Table 5.2.8.7.2.1. Thornback ray in GSA 29. Biological parameters.

	Growth	Length-Weight relationships	Natural mortality (fixed)
Sex combined	L_∞ = 119.3 cm TL k = 0.131 t_0 = -0.67	a = 0.0035 b = 3.1421	0.15

Table 5.2.8.7.2.2. Thornback ray in GSA 29. Vector of proportion of matures.

Age	1	2	3	4	5	6	7	8	9	10	11	12
Prop. Mat.	0.0	0.0	0.0	0.0	0.0	0.25	0.5	0.75	1.0	1.0	1.0	1.0

Table 5.2.8.7.2.3. Thornback ray in GSA 29. Landings (t) by country.

Year	Bulgaria	Romania	Georgia, Russia, Ukraine	Turkey
2008	50.0	NA	NA	117.0
2009	49.0	NA	NA	264.0
2010	72.2	NA	NA	102.0
2011	6.7	NA	NA	80.8
2012	48.3	NA	NA	93.8
2013	56.1	NA	NA	77.1

2014	70.3	0.2	NA	26.0

Table 5.2.8.7.2.4. Thornback ray in GSA 29. Catch at age (thousands).

Age	2008	2009	2010	2011*	2012*	2013	2014
1	26.0	24.5	27.9	44.3	30.5	24.4	1.4
2	43.8	49.0	53.7	91.7	63.1	50.4	10.1
3	14.6	8.2	25.9	56.9	39.2	31.3	11.1
4	11.4	57.1	65.7	135.9	93.6	74.8	21.6
5	9.7	70.7	33.8	47.4	32.6	26.1	7.6
6	40.6	29.9	55.7	101.2	69.7	55.7	12.2
7	63.3	19.0	29.9	37.9	26.1	20.9	14.7
8	66.6	35.4	59.7	34.8	23.9	19.1	7.6
9	105.5	70.7	23.9	34.8	23.9	19.1	14.7
10	26.0	16.3	6.0	9.5	6.5	5.2	2.2
11	14.6	2.7	4.0	6.3	4.4	3.5	0.7
12	4.9	0.0	0.0	3.2	2.2	1.7	1.4
*Age structure for 2011 and 2013 was borrowed from 2013 data							

5.2.8.7.3 Results

Yield-per-Recruit (Y/R) and Spawning Stock Biomass per recruit (SSB/R) output curves are illustrated in the Figure 5.2.8.7.3.1.

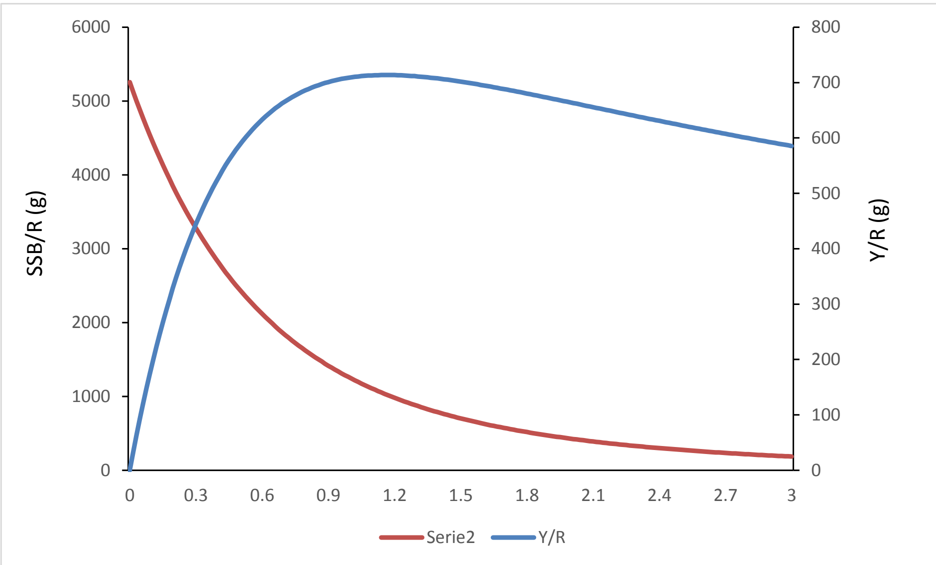


Figure 5.2.8.7.3.1. Thornback ray in GSA 29. Yield-per-Recruit (Y/R) and SSB-per-Recruit (SSB/R) curves (year 2014).

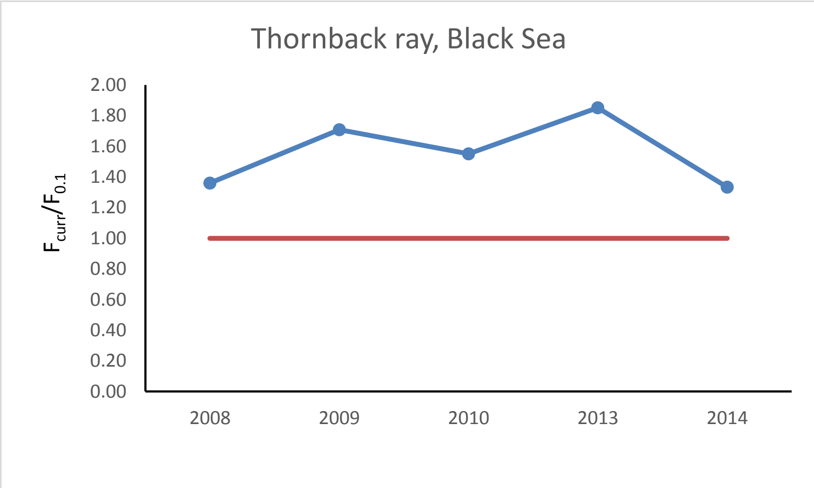


Figure 5.2.8.7.3.2. Thornback ray in GSA 29. Trend of $F_{curr} – F_{0.1}$ ratio.

Table 5.2.8.7.3.1. Thornback ray in GSA 29. Main outputs of the pseudo-cohort analysis carried out by means of VIT program.

		F	Y/R
2008	F_0	0.00	0.0
	$F_{0.1}$	0.17	782.8
	F_{curr}	0.23	820.7
	F_{max}	0.29	828.9
2009	F_0	0.00	0.0
	$F_{0.1}$	0.17	715.4
	F_{curr}	0.29	750.1
	F_{max}	0.27	751.4
2010	F_0	0.00	0.0
	$F_{0.1}$	0.16	660.6
	F_{curr}	0.25	691.0
	F_{max}	0.25	691.1
2013	F_0	0.00	0.0
	$F_{0.1}$	0.15	633.5
	F_{curr}	0.27	655.6
	F_{max}	0.22	662.9
2014	F_0	0.00	0.0
	$F_{0.1}$	0.15	680.2
	F_{curr}	0.21	709.3
	F_{max}	0.24	713.7
Mean values	$F_{0.1}$	0.16	
	F_{curr}	0.25	
	F_{max}	0.25	

5.2.8.8 Reference points

5.2.8.8.1 Methods

Yield-per-recruit analysis was used to estimate reference points for Thornback ray in the Black Sea.

5.2.8.8.2 Input data

Input data were the same as those used to carry out pseudo-cohort analysis by means of VIT program.

5.2.8.8.3 Results

EWG15-12 proposes $F_{0.1}$ = 0.16 as limit management reference point consistent with high long term yields (i.e. proxy of F_{MSY}).

5.2.8.9 Data quality

The lack of a fishery independent scientific survey to monitor thornback ray all over the Black Sea appears the major data deficiency in the assessment. EWG 15-12 recommends such a survey to be established, as it will allow to obtain time series of data on abundance, recruitment, total mortality, spatial distribution, etc. In addition, it is recommended to improve the quality of catch statistics regarding thornback ray in the Black Sea area. Catch-at-age data is crucial for conducting an assessment in the future. Landings from Russia, Georgia, and Ukraine were not provided to EWG 15-12. Data from Romania were available for 2014 only.

The EWG considered the data quality good enough to interpret the assessment as indicative of trends only, due to the lack of catch at age data from several countries and an internationally coordinated bottom trawl survey.

5.2.8.10 Short term predictions 2015-2017

5.2.8.10.1 Method

No short term forecast was performed as the assessment is only indicative of trends.

5.2.8.11 Medium term predictions

5.2.8.11.1 Method

Not conducted.

5.2.8.12 Stock advice

STECF EWG 15-12 advises the relevant fleets' catches and/or effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level (0.16), in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches of Thornback ray in GSA 29 in 2016 consistent with F_{MSY} cannot be estimated as the assessment is only indicative of trends.

6 IDENTIFICATION OF AREAS AND PERIODS WITH HIGH OCCURRENCE OF JUVENILES AND/OR SPAWNERS OF TURBOT AND PIKED DOGFISH

In Black Sea series of measures have been introduced for protection and sustainable utilization of turbot and piked dogfish (GFCM, 2014). In table 6.1. are listed common and specific measures for turbot and picked dogfish, which refer to juveniles conservation of both species.

Table 6.1. Management measures to protect the turbot (A) and picked dogfish (B), including juveniles.

(A)

Bulgaria	MPAs in 16 sites (NATURA 2000) Fishing is prohibited within 1 mile zone around ports and estuaries Closed season 15 Apr-15 Jun (possibility of shifting and extension) Minimum landing size 45 cm (TL)
Romania	Fishing prohibited in waters less than 20 m depth as well as estuaries in Danube Delta Marine Reserve, Vama Veche-2 Mai Reservation
Ukraine	Closed areas Restriction on gill net dimensions: length 100m, number of meshes in height 8 units Minimum landing size 35 cm (SL) Minimum mesh size gillnet 180 mm from knot-to-knot Closed seasons (1 Nov-31 Jan; 1 -31 May - for the EEZ and 15 days for the territorial waters within the month of May) Undersized fish as by-catch is regulated TACs, divided also with by-catchers Limitations in number of gears as a total as well as minimum number of gears per vessel Bottom trawling banned Restriction on gill net dimensions: length 100m, number of meshes in height 8 units
Turkey	Closed areas for trawls and purse seines Closed season 15 Apr-15 Jun for gillnets Trawlers do not operate within 3 nautical miles from the coast Monofilament nets are prohibited No new licenses are issued Closed seasons for bottom trawls (15 Apr-15 Sep) Long lines and trammel nets forbidden Turbot stock enhancement project in place Mesh size in the trawler codend not less than 40 mm
Georgia	Fishing with purse seines and trawls is prohibited within 300 m from the shore Closed season from 1 May to 1 July o Restricted areas (MPAs) Minimum landing size 35 cm (SL) Minimum mesh size gillnet 120 mm from knot-to-knot TACs for trawls and seines (estimated by NGOs)

(B)

Bulgaria	MPAs in 16 sites (NATURA 2000) Fishing is prohibited within 1 mile zone around ports and estuaries Minimum landing size 45 cm (TL)
Romania	Gillnet mesh size a = 100 mm Fishing prohibited from 15 Mar-30 Apr Catching spawning females prohibited throughout the year Minimum landing size 120 cm (TL)
Ukraine	Regulated through TACs Minimum landing size 85 cm (SL) Minimum mesh size 100-120 mm from knot-to-knot By-catch while trawling is restricted (not more than 200 kg per each operation and not more than 50% in the case of higher catches) Turbot by-catch in trawl catches of sprat should be less than 4 individuals per one ton Bottom trawling banned
Turkey	No specific measures for dogfish in Turkey
Georgia	Regulated for trawls and seines through TACs

In Ukraine a series of specific measures were introduced aiming protection of young and immature individuals of turbot, sturgeons, piked dogfish and other demersal species:

i. The zone to the North from the line connecting Cape Tarkhankut and Dnestrovski lighthouse. Prohibited for trawling for longlines and gillnets (100mm) for Piked dogfish. Restrictions in number for 45-70 mm gillnet the most dangerous for youngsters of sturgeons, turbot and piked dogfish. Total ban of this small meshed gillnets in summer-autumn period till the 15th of October.
ii. Tendrovskiy Bay is prohibited totally all year round for all gears.
iii. Karkinistki Bay – trawling is prohibited totally in this zone and longline prohibited. All gillnets in the range 40-100mm are prohibited all year round. The turbot gillnets are allowed at the level of 100 single nets. The length of single net should be less 100 m.
iv. The zone to the west of meridian 30.00 is prohibited for trawling for longlines and piked dogfish with nets of 100mm. There is a ban in summer-autumn period for gillnets in the range of 45-70.

According to survey conducted by Yoseda et al., (2012), in the area of Trabzon, Turkey, (1997-1999) a total of 422 specimens were collected by 364 otter trawl nets during 95 cruises. Data of CPUE at different depths (Fig.6.1) indicated the highest value of 1.7 at 10 m depth. CPUE showed a tendency to be higher at depths shallower than 20m compared to depths deeper than 30 m depths. Obviously, a combination of physical and biotic factors is important in determining the level of recruitment. Some of these factors may also be correlated to each other /or act in concert. For example temperature has a direct effect on several processes that could affect recruitment (Martinson, 2011). However, it could not be establish a clear mechanism of migration behavior explaining why turbot can distribute in a wide range of seabed water temperatures.

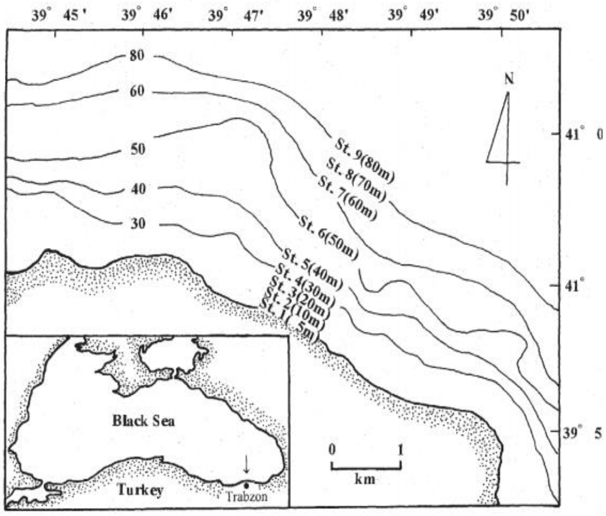


Figure 6.1. Location of the surveyed area and sampling points for water temperature indicates St. 1 St. 9 off Trabzon in the eastern of the Black Sea. (Source: Yoseda et al., 2012).

Seasonal and vertical changes in occurrence of the turbot at different depths are shown in Fig. 6.2. Their distribution was restricted by water temperature during the survey periods. Between July and August, turbot had a tendency to migrate to deeper layers, especially in August they distributed significantly in deeper layers ($P<0.05$). However, turbot widely distributed at 5 - 70 m depths between August and March; only in November and December turbot was found in shallow coastal areas at 5-10 m. In contrast, it was concentrated at 10- 40 m depths between April and July.

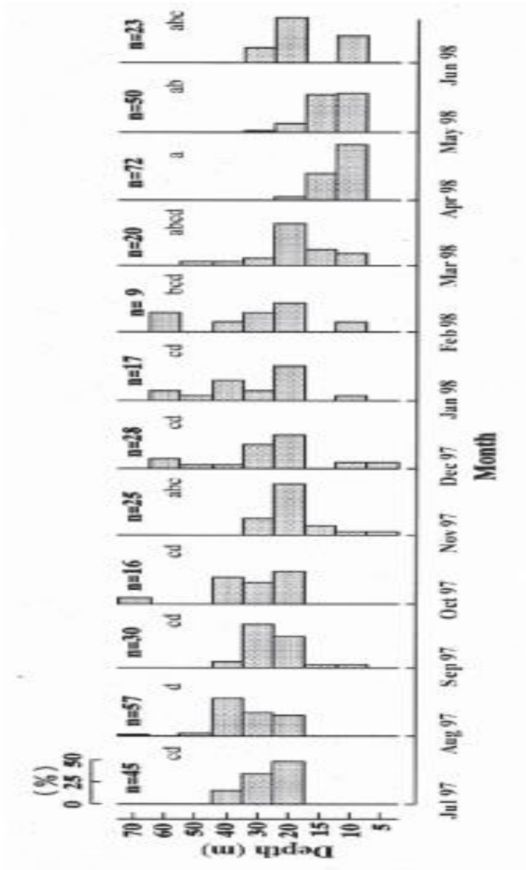


Figure 6.2. Seasonal and vertical changes in occurrence (%) of Black Sea turbot off Trabzon in the Black Sea (Yoseda et al., 2012).

Yoseda *et al*., 2012 indicated that turbot was distributed widely at seabed temperatures of 8.0 - 26.4℃ and at 5 - 70 m depths during the survey periods. The same authors revealed that the seasonal migrations were divided into three patterns determined by seabed temperature as follows:

i. turbot distribute mainly over 10-50 m depths between July and October when variance of the water temperature on seabed was large (10-26 °C);
ii. turbot distribute widely at 5 - 60 m depths between November and March from deeper layers to shallow coastal areas when the water temperature was more homogenous;
iii. turbot was concentrated between 20 and 30 m depths in April and May

It is not clear the reason why turbot select different water temperatures on the seabed at 10-26 °C. Turbot distribution between 5 - 60 m depths between November and March was assumed to be a foraging migration. Popova (1954) also stated that turbot migrate from deeper layers to shallow coastal areas to forage for food in autumn off the coast of Georgia. The large concentration of turbot between 20 and 30 m depths in April and May is assumed to be a spawning migration as shown by the occurrence of large amount of fertilized eggs in this period. Hara *et al.* (2002) indicated that the spawning season peak is from April to May based on the gonadosomatic index for consecutive years by monitoring fish purchased from the Trabzon market. From viewpoints of these results, it is likely that turbot aggregate in shallow coastal areas especially under 20 m depths for spawning. Gordina and Morochkovskiy (1994) assumed that the spawning ground of the Black Sea turbot is confined to 40 - 50 m depths based on egg occurrences, and at seabed temperature of 10 - 12°C off the coast of Sevastopol in the Ukraine. Gordina (1999) recently described spawning grounds of turbot at 20 - 50 m depths based on analysis of collected eggs. There are some differences in the depth of spawning grounds estimated between different studies. Different sampling methods and differences in oceanographic conditions among regions could be a possible explanation.

According to the survey under “Operational Program Environment 2007-2014” Field studies of the distribution of species / assessment of the status of species and habitats throughout the country - Phase I- “Fishes”, 2 otter trawl surveys were conducted in July and September 2014. Additionally, in almost all stations replicates were done. Historical data from surveys were used for mapping the spatial and temporal distribution of turbot (Fig.6.3).

The coverage of surveys was in the 12 mile zone of Bulgarian Black Sea waters. The results of juvenile distribution are presented on the figure 6.3. A and B. The field studies were conducted in July and September 2014. Juveniles and immature specimen displayed restricted habitat requirements, being mainly concetrated on sandy locations.

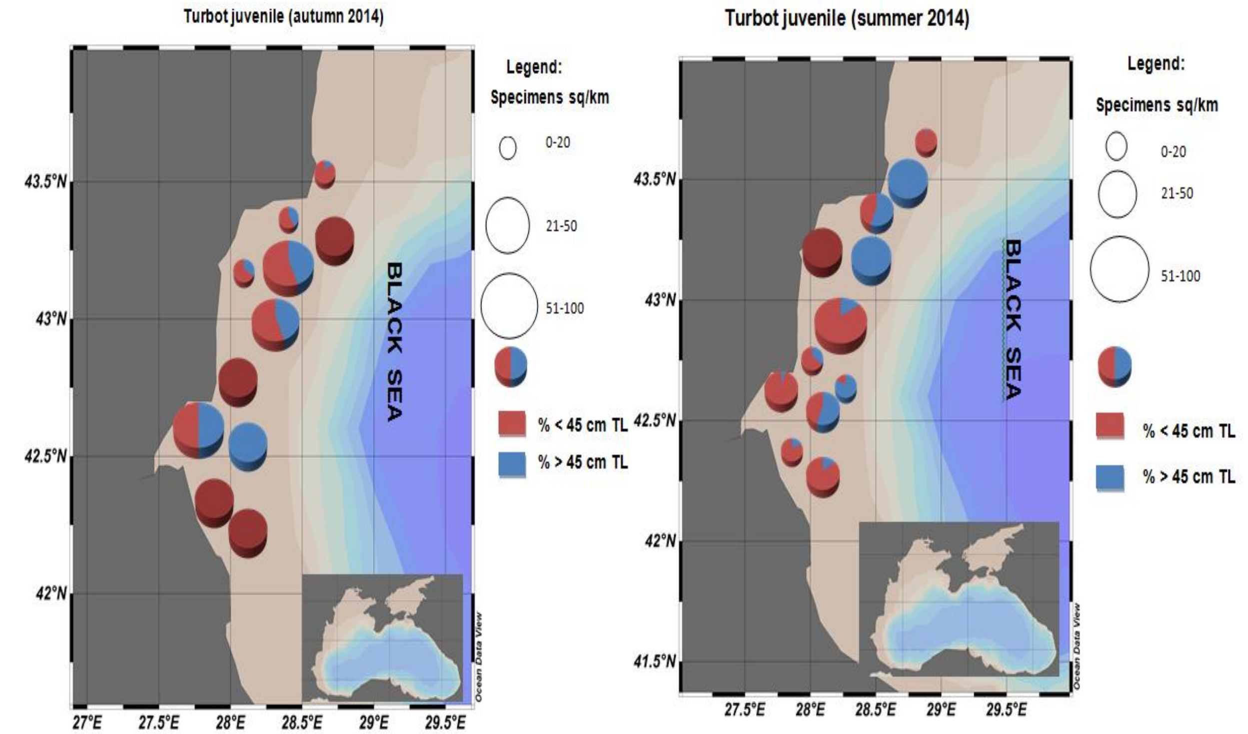


Figure.6.3. Map of turbot juvenile distribution in Bulgarian Black Sea in July 2014 (A) and in September 2014 (B).

In July turbot immature individuals (<45 cm TL) were predominant in the Bulgarian marine area, especially in shallow waters (Fig.6.3 A). The maximum length observed was 56.2cm. Turbot individuals ranged from 22 to 40 cm in summer in the near shore area between 22 and 65.3 m depth. In September 2014 (Fig.6.3 B) the bulk was composed by length groups 33-40cm, distributed in depths of 26.6 to 68.1m, as the specimen with total length of 15-28 cm were less in terms of abundance in the near shore zone with depths of 21 to 58.2m. In Romanian Black Sea waters spring and autumn surveys were conducted (Fig.6.4 A, B). It is evident that in summer 2014, the percent of immature specimen in the area between 10 and 30m depth is limited. In autumn 2014, the immature individuals significantly increased (Fig.6.4.B).

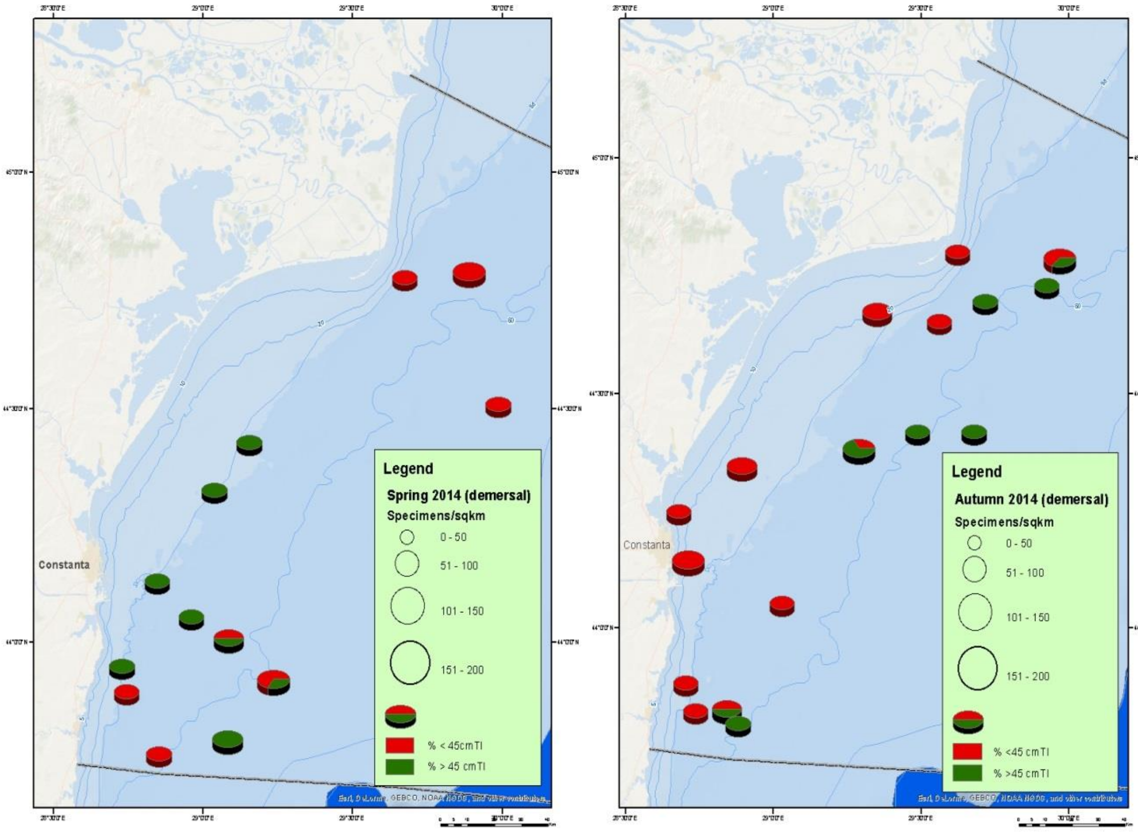


Figure 6.4. (A). Map of distribution of mature and immature individuals in Romanian Black Sea waters in spring 2014 and in autumn 2014 (B).

No maps on spatial and temporal distribution on juveniles or/and spawners of turbot were presented for Turkey, Ukraine, Georgia and Russian Federation.

Mapping of distribution of turbot (BSERP, 2006) juveniles and larvae in the Ukrainian sector was estimated on the basis of YugNIRO summer ichthyoplankton surveys with Bongo nets and Danilevsky's pelagic trawl. In the Ukrainian sector two main areas of spawning are located. They are as follows: coastal waters adjacent to the western extremity of the Crimea peninsula, including the Karkinitsky Bay and the eastern coast of the Crimea. The most intensive spawning is observed in May. Eggs are pelagic; they keep in the upper layers of water; due to this it may spread by currents far from spawning sites. However, grounds with increased density of juveniles and larvae of turbot are located in the immediate vicinity of major spawning sites – near western and eastern coasts of the Crimea within the shelf zone (Fig. 6.5A). Turbot juvenile distribution in Bulgarian and Ukrainian waters is presented in Fig.6.5B.

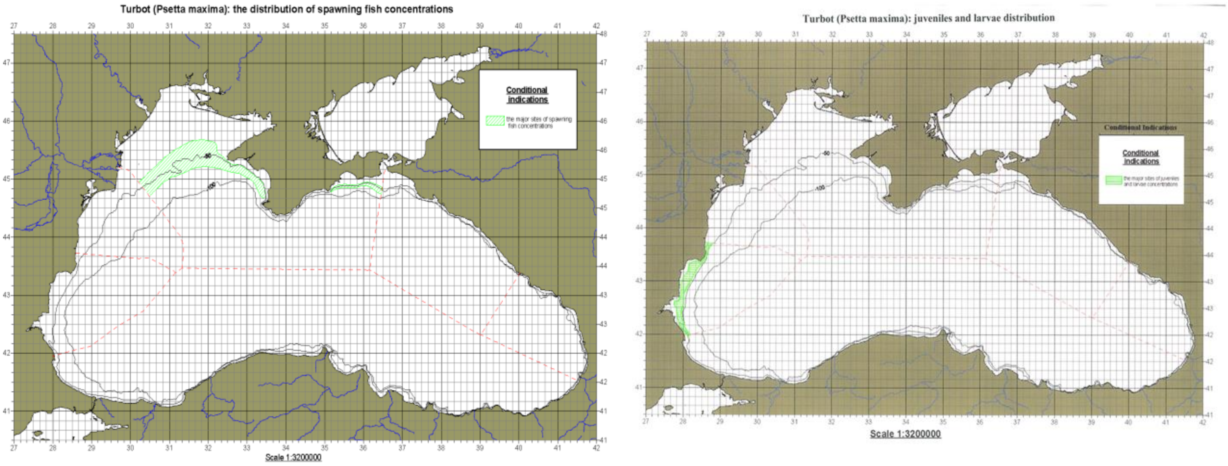


Figure 6.5. A: distribution of spawning turbot in Ukrainian waters B; juvenile and larvae distribution in Bulgarian waters.

Piked dogfish

Reproductive migrations of Piked dogfish take place to the coastal shallows areas with two peaks of intensity – in spring and autumn. The major grounds for reproduction of Piked dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay (Radu *et al*., 2011). Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba et al., 1988). To give birth females approach the coastal zone in depth 10 – 30 m (Maklakova, Taranenko, 1974). At this time males keep separately from females in depth 30 – 50 m. The birth of Piked dogfish juveniles takes place at water temperatures of 12 – 18°C. In Romanian waters the spawning aggregations are distributed on the entire shelf, but especially at depths more than 20m. Two peaks of intense spawning and birth of juveniles are in spring and autumn period at Romanian littoral.

Mapping of distribution of piked dogfish juveniles in the Ukrainian sector was made on the basis of materials produced during YugNIRO register surveys, namely: piked dogfish surveys with bottom trawl in summer period (June), surveys for bottom fishes in spring (April-May) and autumn (September-October) periods and winter-spring surveys for whiting (February-March, December). In the northwestern Black Sea the largest concentrations of piked dogfish juveniles in the warm period of a year are usually observed in depth from 40 m to 50 m, and in winter period – from 50 to 60 m. Although sometimes in February-March they may occur in large depths down to 90-100 m. The most typical distribution of juvenile concentrations of piked dogfish are characterized by depth 40 – 60 m with water temperature 7-12ºC from the border with the Romanian sector to the cape Tarkhankut and from the cape Chauda to the border with the Russian sector.

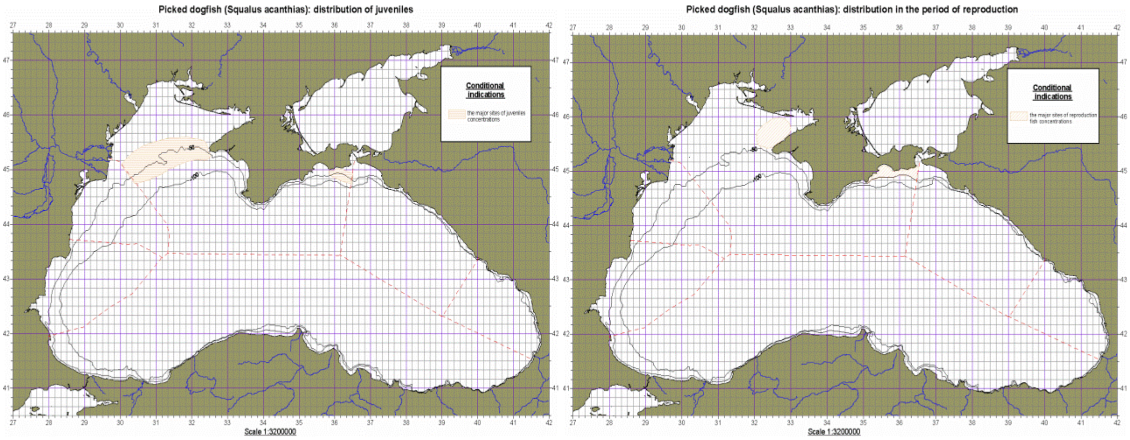


Figure 6.6. Piked dogfish distribution of juveniles and during the period of reproduction.

Conclusions

General

- Information of the distribution of juveniles or/and spawners of turbot and piked dogfish is generally scarce. There is the need for conducting internationally coordinated demersal surveys in the Black Sea in order to increase the knowledge on the mechanisms behind the spatial and temporal distribution of turbot and piked dogfish in the Black Sea.

Turbot

- No information on the spatial and temporal distribution on juveniles or/and spawners of turbot is available for Turkey, Georgia and Russian Federation.
- In Romanian, Ukrainian and Bulgarian waters, spawning grounds of turbot are concentrated between 10 - 40 m depths in April and May.
- In Romanian and Bulgarian waters, juveniles and immature turbot displayed restricted habitat requirements, being mainly concentrated on sandy locations in shallow waters.

Piked dogfish

- No information on the spatial and temporal distribution on juveniles or/and spawners of piked dogfish is available for Turkey.
- Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine spawning season of piked dogfish is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn along coastal zone at depths of 10 – 30 m. The major grounds for reproduction of piked dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.
- The distribution of juvenile concentrations of piked dogfish is characterized by depths around 40 – 60 m with water temperatures of 7-12ºC from the border with the Romanian sector to the cape Tarkhankut and from the cape Chauda to the border with the Russian sector.

7 DATA QUALITY AND COMPLETENESS

7.1 COVERAGE, COMPLETENESS AND QUALITY

The data call issued on April 2015 for the Black Sea and had a legal deadline on 24th August 2015 and an operational deadline on 11th Sep 2015. Romania submitted two tables one day after the legal deadline. JRC identified lack of minimum required information in some Bulgarian submissions. More problems were identified by the EWG 15-12 experts and an official request was sent to the Bulgarian national correspondents to deal with these issues, leading to two re-submissions on 28 Aug and 25 Sep 2015.

Table 7.1.1. Timeline of data upload from Black Sea Member States; data call **'legal' deadline of the 24t^{h} of August 2015; 'operational' deadline 11 September 2015**.

COUNTRY	First Upload	Last Upload
BUL	21 Aug 2015	24 Aug 2015*
ROM	18 Aug 2015	25 Aug 2015**

*: *additional submissions on 28 Aug and 24 Sep 2015 upon a request by JRC Data Collection Team and the EWG 15-12*

**: *Effort and Abund_Biom tables were submitted one day after the legal deadline upon a request by JRC Data Collection Team.*

Data Overview

A summary of the main data gaps is presented below (by country and by stock) while more specific issues related to individual stocks are described in the dedicated chapter under each stock assessment section.

Bulgaria	• No Discards data submitted • Effort submitted for 2013-2014 is extremely low. Upon a request by JRC, Bulgarian authorities pointed out that species-specific effort might have been submitted instead. No corrected data was re-submitted. • Catch@Age and Landings@Length data are absent • Survey data only for 2014 were submitted. Abundance and biomass estimates for turbot were identified as incorrect by EWG 15-12 experts. The raw survey data were requested by EWG 15-12. • All biological parameters data (maturity, sex-ratio, age & growth) are unrealistic or at least questionable.
Romania	• Sex-ratio data are unrealistic or at least questionable.

Sprat	• data are missing for Russian and Georgia • age composition and commercial CPUE data are becoming scarcer • an hydroacoustic survey covering the entire Black Sea is lacking
Turbot	• catch at age data not avalable for the whole time series. • share of the IUU fisheries by countries was not reported but it was estimated • available survey indices are limited only to the EU countries and there is no fishery independent information about the status of the turbot population for the rest of the coastal states.

	• No information were provided by countries regarding the turbot discards and by-catch depending on the type of the fishing gear.
Red mullet	• lack of a research trawl survey • uncertainties in the identification of the fish species in the catches
Anchovy	• problem in ageing: reflects on the inconsistency of weight at ages and in the reported vs estimated landings. • survey data (hydro-acoustic) displayed very high internal inconsistency and were not used.
Mediterranean horse mackerel	• commercial CPUE index used is a very raw index • lack of a dedicated hydro acoustic survey.
Piked dogfish	• lack of a fishery independent scientific survey • age reading of dogfish needs to be calibrated between different national laboratories • Discards data were considered unreliable and not used in the assessment. In some years very high values have been reported.
Whiting	• lack of international hydro-acoustic/bottom trawl survey. • a calibration of the age reading of whiting is needed • poor information of discarding rates for most of the countries
Thornback ray	• lack of a fishery independent scientific survey • catch statistics are questionable.

Main issues need to be addressed:
Country level

- General lack of catch at age or catch at length data for Bulgaria
- No discards data from Bulgaria

Stock level

- General lack of fishery independent surveys
- Age reading inconsistencies among varipous countries/institutes

More detailed issues on data quality/coverage can be traced in the detailed assessments section (5).

8 BYCATCH IN RAPA WHELK FISHERIES AND THEIR IMPACT ON OTHER STOCKS

8.1. Present state of Rapa whelk in the Black Sea

8.1.1. Stock identification and distribution

Rapa (veined) whelk *Rapana venosa* Val., 1846) *(syn. Rapana thomasiana* Crosse, 1861) was introduced into the Black Sea in 1946 and it expanded along the Caucasian and Crimean coasts and to the Sea of Azov within a decade. Its range extended into the northwest Black Sea to the coastlines of Romania, Bulgaria and Turkey from 1955 to 1969 (Fig. 8.1.1). It is well established in the benthic ecosystem of all the Black Sea coastal states and has exerted significant predatory pressure on the indigenous malacofauna (Black Sea TDA, 2008).

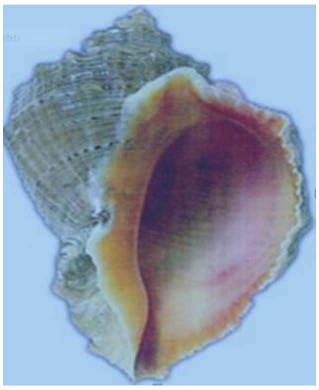


Fig. 8.1.1. Distribution area and time of Rapa whelk in the Black Sea (Novorosisk (1947), Crimea (1949), Romania (1955), Bulgaria (1957), Istanbul (1960), Marmara (1966), Aegean (1969), Giresun (1955), Trabzon (1962)).

The whelk population has spread gradually onward to 1970's and also its stock has started increasing in coastal benthic habitats extremely in 1980s. Rapa whelk has established and pressured on the bivalve communities for predation in the shallow waters in the Black Sea coast of Turkey (Bilecik, 1990).

Introduction of this predatory mollusk into the ecosystem of the Black Sea turned out to be a catastrophy for oyster biocenoses. Distribution of Rapa whelk is associated with reduction of mussel banks in particular near the coasts of Anatolia and Caucasus. In the Ukrainian waters Rapa Whelk destroyed the oyster banks in the area of the Kerch Strait and in Karkinitsky Bay, biocenoses of other mollusks associated with depth down to 30 m suffered as well.

The impact on bivalve populations is variable and ranges from rather mild along the Romanian coast possibly due to suboptimal environmental condition, moderate in Bulgarian and Turkish Black Sea, and severe along Russian and Ukrainian coasts, where the whelk has been blamed for local exterminations or major declines in the numbers of other bivalves (Black Sea TDA. 2008). In the Black Sea, *Rapana venosa* occurs on sandy and hard-bottom substrates to 45 m depth. The highest abundance occurs in the Kerch Strait at the entrance to the Sea of Azov, near Sevastopol and Yalta (Ukraine), and along the Bulgarian coast (ICES, 2004). In the Black Sea coasts of Turkey, it was observed that 74% of the stocks were found up to 10 m, 24% within 10-20m and 2% at more than 20 m of depth (Duzgunes et al., 1992).

8.1.2. Impacts

8.1.2.1. Ecological impacts

The invasion of the Black Sea by *Rapana venosa* severely affected shellfish stocks in the Black Sea, by reducing populations of oysters (*Ostrea edulis*), scallops (*Pecten ponticus*), mussels (*Mytilus galloprovincialis*), and clams (*Venus gallina*). Attempts to eradicate *R. venosa* on the Bulgarian Coast were unsuccessful (Chukhchin 1984; Zolotarev 1996).

Rapa whelk has no effective natural predator in Black Sea (as sea stars) and this is the main reason of rapid population increase and invading speed. Its feeding strategy depending dominantly on mussels (Cesari and Mizzan, 1993) and its high rate of predation depleted nearly all bivalve stocks (*M. galloprovincialis, Chamelina gallina, Anadara cornea*) along the coasts from Georgia border to Samsun province. It is recorded that 99% of *C. gallina* population is composed of empty shells in the period of 2002/2003 (Dalgıç and Karayücel, 2006). In the by-catch assessment surveys in Rapana dredges the percentage of empty shells was recorded as 73% and 85% for *Anadara cornea* and *Chamelea gallina*, respectively (Knudsen and Zengin, 2006). Recently, Rapa whelk starts to threaten some other mollusca and crustacean communities (*L. depurator*, Donax sp., Isopods, Amphipods and Decapods).

In the Black Sea, Rapana feeds primarily on bivalve mollusks, paralyzing them with toxins and eating them with the aid of its soft proboscis. In aquariums, *Rapana venosa* eats Mytilus (mussels), Ostrea (oysters), Tapes (clams), Venus (clams), Pecten (scallops), and Cardium (cockles), and the gastropod mollusk Patella (limpets). When Rapana is offered mussels and oysters simultaneously, it clearly prefers the former. This is explained, probably, by the thinner shell of the mussels which Rapana can more easily penetrate. Young-of-the year *Rapana venosa* eat *Balanus improvisus*. *Rapana venosa* may also feed on carrion. In the aquarium, they eat the meat of mussels, oysters, dead fish and crabs (Chukhchin 1984).

It should be noted that in the Black Sea, prior to *R. venosa*'s invasion, there were no large predatory gastropods. The Black Sea lacked predatory marine organisms, including predatory gastropod mollusks which could feed on bivalves. The establishment of Rapana created a new ecological niche.

Most of the catches of rapana are made using dredges or beam trawls. Because these fishing methods disrupt bottom sediments and often produce high rates of bycatch of non-target species, increased harvesting of rapana using dredges or beam trawls is likely to have negative ecological impacts.

Alternative fishing gears as pots/traps are at the trial period in Turkey in line with the importance of research to define the safest fishing techniques for demersal stocks for EU, particularly for the veined Rapa whelk in the Black Sea.

The EWG compiled and examined the available length composition data with respect to their suitability to provide estimates of growth and age composition. It was not possible to distinguish clear indications of cohorts in length compositions tabulated on a monthly or annual basis.

8.1.2.2 Social Impact

In the Black Sea demersal fisheries have expanded as the target has changed from fish stocks such as the almost depleted turbot (*Scophthalmus maximus*), mullet (Muglidiae) and whiting (*Merlangius merlangus*) to the whelk. This is a unique case of a fisheries expansion where most are declining, and has led to concurrent social changes (e.g. influx of new fishers to the sector) in fishing communities such as Samsun on the Turkish Black Sea coast (BSEP, 2007). In the Black Sea (e.g. Bulgaria, Turkey), commercial fisheries have developed for R. venosa, in which the snails are shipped to Japan and Korea.

There are 117 fishermen in Romania, about 1000 in Turkey, 300 in Bulgaria (working at several shifts in beam trawl vessels), about 30 divers in Ukraine and 100 divers in Russia directly engaged in Rapa whelk fisheries in 2014. After the decline in many fisheries Rapa fishing became a new employment field in the riparian countries (expert viewvs).

8.1.2.3 Risk and Impact Factors

Impact mechanisms are its high predation, fast recruitment and rapid growth rate.

8.1.2.4. Impact outcomes

Major impact outcomes are the conflicts, modification of natural benthic communities, negatively impacts aquaculture/fisheries, reduced native biodiversity, threat to/ loss of endangered species, threat to/ loss of native species.

8.1.3. Uses

8.1.3.1. Economic Value

This is a species of economic value. Demand for its meat on the international market has enhanced commercial fisheries initially in Turkey (1980s), and then in Bulgaria (1990s), while in Romania quickly developing medium-to-large subsistence harvesting is very likely to become an export-oriented industrial fishery in the coming years (BSEP, 2007).

As the fish resources decline, Rapa fisheries is getting much more importance due to its economic value. According the 2011 figures, total value of the revenues from fisheries in the Black Sea is over € 364 million and € 11 million comes from Rapa whelk fisheries (3%) (Goulding et al, 2014). Moreover, total revenues from Rapa fisheries are increasing in Bulgaria, Romania and Ukraine where other fishery resources are getting poorer. In Bulgaria catch of Rapana covers 45 % of the total landings with the value of € 1,547,781 which is 35% of the total revenues from fisheries. It is going to be same for the Romanian fisheries as the production increases. Rate of Rapa whelk in the total fisheries and incomes in the total revenues are 9% and 15 % for Turkey, and 48% and 26% for Ukraine (Table 8.1.3.1.1).

According to the Turkish data, revenues per vessel are still important for the Rapa whelk fishermen even though there is regular decrease since 2004. After processing, export income plays and important role in Turkish fisheries economy. After the decline in turbot fisheries in Turkey, artisanal fishermen prefer to harvest Rapana as a new income source. Average export revenue in 2014 is about €4 million (Table 81.3.1.2) (TURKSTAT, 2015).

Table 8.1.3.1.1 Average catches by species and values of fish in the Black Sea, 2006–2010 (value in 2011 prices) (Goulding et al, 2014).

Species	2011 Price (EUR/kg)†	Bulgaria Catch (t)	Bulgaria Value (€)	Georgia Catch (t)	Georgia Value (€)	Romania Catch (t)	Romania Value (€)	Russian Federation Catch (t)	Russian Federation Value (€)	Turkey Catch (t)	Turkey Value (€)	Ukraine Catch (t)	Ukraine Value (€)	TOTAL Catch (t)	TOTAL Value (€)
Whiting	2.35	7	15,494	25	57,752	44	102,357	67	156,822	11,234	26,374,321	24	57,282	11,400	26,764,029
Turbot	15.12	47	710,648	–	–	47	704,600	–	–	550	8,313,070	254	3,847,479	898	13,575,797
European anchovy‡	0.79	40	31,746	20,321	16,047,801	27	21,006	9,654	7,624,076	259,113	120,155,992	12,919	10,202,145	302,075	154,082,765
Sardine	0.86	2	2,060	–	–	–	–	–	–	7,068	6,066,609	–	–	7,070	6,068,670
European sprat	0.31	3,708	1,161,859	–	–	215	67,298	7,978	2,499,482	33,702	10,559,058	21,938	6,873,223	67,541	21,160,920
Grey mullet	2.09	13	28,008	5	9,615	10	21,319	2,274	4,752,535	3,041	6,355,664	6,022	12,587,257	11,365	23,754,397
Breams	8.94	–	–	–	–	–	–	–	–	142	1,267,680	–	–	142	1,267,680
Seabasses	8.97	–	–	–	–	–	–	–	–	134	1,206,139	–	–	134	1,206,139
Bluefish	5.18	31	162,660	–	–	–	–	–	–	5,149	26,675,218	–	–	5,181	26,837,878
Mussels	0.47	35	16,186	–	–	3	1,497	–	–	1,316	615,733	379	177,113	1,733	810,530
Red mullet	7.41	44	328,808	1	10,368	1	4,443	–	–	2,751	20,371,268	77	571,859	2,874	21,286,746
Mediterranean horse mackerel	1.80	140	252,721	26	47,588	10	18,026	156	281,562	16,803	30,288,670	307	554,148	17,443	31,442,714
Atlantic horse mackerel	1.80	–	–	–	–	–	–	–	–	6,304	11,362,712	–	–	6,304	11,362,712
Mackerels	3.77	0	754	–	–	–	–	–	–	527	1,986,239	–	–	527	1,986,994
Rapana	0.45	3,400	1,546,781	470	214,002	0	182	6	2,730	9,718	4,421,064	202	91,988	13,797	6,276,747
Venus clams	0.30	–	–	–	–	–	–	–	–	36,691	11,180,397	–	–	36,691	11,180,397
Others	3.04	66	201,765	4	13,370	19	57,734	125	378,613	1,252	3,803,814	163	495,296	1,629	4,950,591
Total		7,535	4,459,491	20,853	16,400,495	375	998,462	20,260	15,695,820	395,494	291,003,649	42,286	35,457,789	486,804	364,015,706

†Prices are adjusted to two significant figures; values are calculated on the basis of actual prices
‡Average price is anchovy for human consumption except for Turkey, where average weighted value in 2011 was €0.46/kg (44% to human consumption @ €0.79/kg and 56% to fishmeal @ €0.21/kg) (Sources: Turkish Statistics 2011, FIGIS 2013).

Table 8.1.3.1.2 Total revenues from Rapa whelk fishery in Turkey.

Year	Landings (t)	# vessels	Price[1] (€/kg)	Revenue per vessel (€)	Total revenue (€)	Export as processed meat(€)
2004	14034	495	0.42	12034	5956706	8815925
2005	12156	596	0.54	10992	6551138	9695684
2006	10910	555	0.56	10921	6061111	8970444
2007	13106	504	0.56	14625	7371204	10909381
2008	11268	377	0.53	15764	5943038	8795696
2009	6085	124	0.37	18023	2234844	3307570
2010	5460	239	0.39	8959	2141177	3168941
2011	7770	294	0.46	12065	3547028	5249602
2012	8893	483	0.40	7352	3551024	5255516
2013	8655	580	0.42	6324	3667663	5428148
2014	6199	437	0.42	5907	2581139	3820086

[1]based on real exchange rates

8.1.3.2 Environmental Services

R. venosa manifested the most bioaccumulation capacity of Cd (cadmium). *R. venosa* and the short necked clam *Ruditapes philippinarum* were promising bioindicators for monitoring Cd and Ni (nickle) pollution in waters (GISD, 2005). Another indicator is the tributyltin (TBT) which is the inducer of imposex. It can be active even in extremely low concentrations. TBT is an anti-fouling agent in paints for boats. If TBT exists in the bottom sediment, it may accumulate in the tissue and cause sex differentiation (females to males). The growth of a penis in imposex females gradually blocks the oviduct, although ovule production continues. An imposex female whelk passes through several stages of penis growth before it becomes unable to maintain a constant production of ovules. Later stages of imposex lead to sterility and the premature death of the females of reproductive age, which can adversely affect the entire population. The imposex stages of female whelks) are used to monitor levels of tributyltin in the United Kingdom and worldwide. The RPSI (Relative Penis Size Index) of females to males, and the VDSI (Vas Deferens Sequence Index) are used to monitor levels of tributyltin in marine environments. Though the use of TBT is banned, its residuals are still effective on imposex and growth of penises may continue after the ban on tributyltin. So, existence of imposex individuals in Rapana population in a given locality will help biomonitoring of the environment.

8.1.4. Prevention and Control

Education and public awareness campaigns were held in Canada (Cheaspeke Bay) together with bounty programs for individuals collected by the people (carried out by Virginia Institute of Marine Science). There is also guidance to destroy egg cases when found (ICES, 2004). The significance of public awareness concerning invasions is evident in the ICES (2004) report on R. venosa, which states that “public education can and must be supported to underscore the potential damaging effects of this species on native species of commercial and/or ecological importance”.
No widely effective control options to eliminate the species are available at the present time, and commercial fisheries represent the most significant way for the collection of R. venosa in numbers to implement control (ICES, 2004).
Many basic biological questions about the reproductive seasonality, egg capsules and larval development of *R. venosa* have still to be answered. Such biological information would be necessary for the development of techniques for re-stocking natural populations in areas where fisheries of this species exist (Saglam and Duzgunes, 2007).

8.1.5. Fisheries

Total Rapa whelk production had decreased 13 % compared to the 2013 levels, with a total of 13403 tons. Turkey is the main producer, harvesting 6199 tons, followed by Bulgaria with 4732 tons, Romania with 1953 tons, Russia with 319 tons and Ukraine with 200 tons. Total production of rapana in 2014 decreased 13% compared to 2012(Table 8.1.5.1, Fig. 8.1.5.1). Catch of Rapana has started in Turkey in mid-1980s and then became an important fishery resource for Ukraine, Bulgaria, and Georgia in the early 1990s. Later beam trawls were permitted in Romania. Despite these positive effects *Rapana venosa* fishery is the reason of a series of negative ecological impacts due to use of fishing gears as beam trawls and dredges which are harmful to the bottom habitat and the biodiversity due to high by-catch rates.
Due to high exploitation rate in Turkey, the rapana harvested from Turkish waters are generally smaller than the rapana in Bulgaria, Romania and Ukraine, which have populations that are relatively under-exploited (STECF, 2011).
At present dredging, beam trawling and diving are the basic methods used to harvest Rapa whelk in the region (Table 8.1.5.2).

Table 8.1.5.1. Total Rapa whelk landings in the Black Sea

	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1984					122		122
1985					78		78
1986					2030		2030
1987					643		643
1988					7195		7195
1989					9239		9239
1990			75		6094		6169

1991			70		3738		3808
1992			110		3519	14	3643
1993			45		3668	3	3716
1994	3000				2607	5	5612
1995	3120	700			1198	303	5321
1996	3260	711			2447	376	6794
1997	4900	118			2021	476	7515
1998	4300	-			3998	369	8667
1999	3800	-			3588	619	8007
2000	3800	184			2140	913	7037
2001	3353	517			2614	395	6879
2002	698	503			6241	91	7533
2003	325	295			5500	149	6269
2004	2428	65			14034	159	16686
2005	511	70			12156	161	12898
2006	2773	300			10910	156	14139
2007	4310	-			13106	201	17617
2008	2872	-			11268	135	14275
2009	2214	-			6085	190	8489
2010	4381	-			5460	225	10066
2011	-	-			7770		7988
2012	3793				8893	509	13783
2013	4819		1357	50	8655	586	15467
2014	4732		1953	319	6199	200	13403

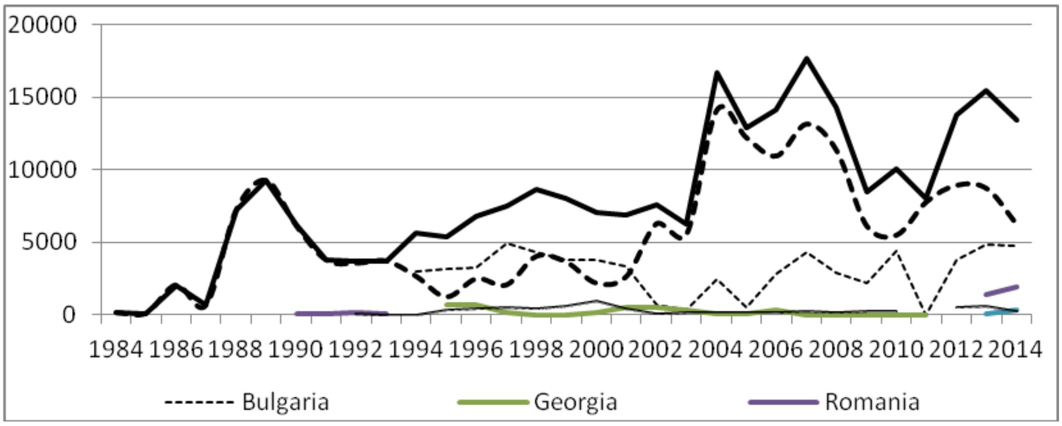


FIG. 8.1.5.1.. Rapa whelk landings by countries.

Table 8.1.5.2. Effectiveness of different harvest methods in the total landings.

Harvest methods	BUL	GE	ROM	RUS	TUR	UK
Dredging		x			x	
Diving	x		x	x	x	x
Beam Trawling	x		x			

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As it is indicated in the last two STECF reports dredge fishery is high in Turkey (95%) and followed by Ukraine (10%) while beam trawls are widely used in Bulgaria (95%) and Romania (74%). Main method applied in Ukraine is collecting by diving.

8.1.6. Effort

Dredge or beam trawl vessels have overall length within 6-17 m in length. A single dredge is used in vessels smaller than 8 m and the larger ones generally used as pair dredging though it is prohibited by government regulations. Total number of licensed vessels is 569 in the Black Sea in 2014 (Turkey: 437, Romania: 32, Bulgaria: 60, Ukraine 10 and 30 in Russia) (Table 8.1.6.1).

Table 8.1.6.1 Number of vessels to harvest Rapa whelk in the Black Sea.

Year	Turkey	Romania	Bulgaria	Ukraine	Russia[1]	
2000	121					
2001	116					
2002	153					
2003	179					
2004	495					
2005	596					
2006	555					
2007	504					
2008	377					
2009	124					
2010	239					
2011	294					
2012	483					
2013	580	21				
2014	437	32[4]	60	10[2]	30 [2,3]	569

[1]includes Crimea [2]estimated boats [3]with Crimean boats [4] 21 are for divers, 11 beam trawlers

8.1.7. By-catch

Juveniles and young turbot, scorpion fish (*Scorpeana porcus*), horse mackerel, goby fish (*Gobius niger*), sole, ray, sea horse (*H. hippocampus*), gurnard, crabs (*Pilumnus hirtellus*), mussels, shrimp (*Carcinus aestuarii*), cockle (*Anadara cornea*) and marine algae (i.e brown algae, *Ulva lactica*) are the main bycatch In Rapa whelk dredge and beam trawl fisheries (Celik & Samsun, 1996; Duzgunes, 2001). Even if the number of species per haul is high, the bycatch rate calculated by number and weight basis is too low (about 4-5 % and 1-2 %, respectively) in Turkey. According to the latest surveys conducted by traditional dredges 88% (see Table below) of catch composed by Rapa whelk, 5% mollusca, 4.5% crustaceans and 2% fish and 0.5% tunicata and others. Romania bycatch rate is reported as 0.1 % on weight and number basis. More efforts needed to collect bycatch data in the entire Black Sea.

Table 8.1.7.1. Discards of the rapa whelk fisheries using dredges.

BYCATCH/DISCARDS	ROMANIA (kg)	BYCATCH/DISCARDS	TURKEY
Rapa whelk	1270	Turbot	*
Sprat	15100	Scorpionfish	**
Goby	600	Goby	**
Horse mackerel	450	Horse mackerel	*
Whiting	150	Ray	*
Red mullet	***	Sea horse	**
Sole	***	Sole	*
Crabs	***	Crabs	**
Flounder	**	Gurnard	*
Turbot	*	Mussels	**
		Shrimp	*
		Cockle	***
		Sea weeds	*
		L. deprator (crab)	**
		Chamelina gallina	**
		Uranuscopus scaber	***

*** some.   ** less   * few

Pot fishery trials as alternative to dredge in whelk fishery is carried out in the Black Sea (Unsal et al., 2004; Sahin 2004; Saglam et al., 2008). These studies claimed that pot fishery seems not profitable as much as dredging, so that to meet commercial expectations of the fishermen (BENTHIS, 2014).

In some of Asian and American countries whelks harvested by 500 to 1000 baited pots lifted per day and per boat. Trials with higher numbers of pots will be useful to compare the catchability, productivity, coast of operations, time spent in the sea, availability under rough sea and weather conditions. On the other hand if the habitat destruction is considered, use of pots and traps are very essential due to higher ecosystem effect index. Experiments with different bait types and pot designs are strongly needed.

8.1.8. Conclusions

EWG 15-12 reiterates STECF conclusions made in 2013 and does not consider F_{MSY} to be an appropriate target for rapana given that it is an invasive predatory species that has had a negative impact on other native Black Sea species. Thus, the goal for managing rapana should not be to achieve the maximum sustainable yield (MSY) and therefore it is not appropriate to constrain fishing activities to achieve high biomass levels of rapana. Fishing for rapana and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the rapana stock below the level consistent with MSY. The negative impact of rapana on its prey is very important to document and monitor. Black Sea nations need better monitoring of the Rapa whelk stock, including the prey-predator relationships, and they need to create common indices to monitor the distribution trend and pattern of Rapa whelk in the region.

The negative impacts of trawls and dredges fishing for rapana on the Black Sea habitat and biodiversity are widely known. More ecological friendly methods and gears should be encouraged (i.e. traps), although it is considered that commercial fisheries is the unique way to eradicate or at least control this species in the Black Sea.

The recently introduced EU Regulation 1143/2014 on invasive alien species (IAS) seeks to address the problem in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. Among others, it also deals with the issue of "Management of already established IAS in the EU". Therein it is quite clear that there is only the option of minimizing or even erradicating them, and this is promoted through a series of succesful efforts on various species (terrestial, marine) accompanied by the optimal methodology for doing so.

However the Committee on IAS will have to draft by the end of 2015 a'black list' of species; following that, all members states facing the problem will have to come up with a series of measures by the end of 2016. It is unclear how will the Rapa whelk be dealt within this Committee taking into account the significant socio-economical aspect of its fishery.

9 IDENTIFICATION AND JUSTIFICATION OF OTHER IMPORTANT FISHERIES AND STOCKS THAT MAY BE IN NEED OF SPECIFIC MANAGEMENT MEASURES TO ENSURE SUSTAINABLE EXPLOITATION AND ANALYSE WHETHER THE SCIENTIFIC BASIS IS ADEQUATE OR NEEDS TO BE FURTHER DEVELOPED

Concerning the other stocks in need of management measures, the FAO data base (FishStatJ) has been checked for the physical and commercial volume of the landings. It is evident that the stocks currently assessed by STECF covers the 95% of the Black Sea marine resources. The only exception is the striped venus, *Chamelea gallina*. This stock is currently exploited only by one country, Turkey. The species exists in the other countries like Bulgaria and Romania, and possibly have exploitable stocks; however as dredging, which is the most efficient tool to harvest this sand/mud buried species, is banned by national and/or EU regulation, development of a new fishery in EU on this stock does not seem very likely.

Among the top 95%, the species which has never been assessed is the bluefish, *Pomatomus saltatrix*. The stock is currently being exploited by almost all countries; Turkish landings being by far greater than any other countries and followed by Bulgaria. Given the reasonably high landings, the very high market value and its evident predatory impact on the ecosystem, bluefish could be a candidate stock to be assessed by STECF. On the other hand migratory behaviour of the species which extends from Aegean Sea in the south and Black Sea in the north complicate the assessment. Therefore, EWG 15-12 considered that the Black Sea STECF WG is not the appropriate fora for this task and that an assessment with a broader geographical coverage embracing different GSAs is required both for the reliability of the assessment results and also for the management of this stock over its entire range.

Amongst the other species considered, namely catadromous grey mullet and anadromous shad are believed to have local populations confined to river mouths and therefore cannot be jointly assessed. Finally mackerel, which used to have a significant stock in the past, is not considered as an important resource nowdays.

As a result, EWG 15-12 considers that currently no other species in the Black Sea is in need of specific management measure for sustainable exploitation.

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11 CONTACT DETAILS OF STECF MEMBERS AND EWG-15-12 List of Participants

Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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12 List of Background Documents

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1512

List of background documents:

1. EWG-15-12 – Doc 1 - Declarations of invited and JRC experts (see also section 11 of this report – List of participants)

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